सत्यमेव जयते

INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI

I.A.R I 6.
GIP NLK—H-3 I.A.R.I.—10 5-55 —15,000

THE OHIO
JOURNAL OF SCIENCE

VOLUME XLIII — 1943

GLENN W. BLAYDES, Editor-in-Chief

PUBLISHED AT COLUMBUS, OHIO, BY THE

OHIO STATE UNIVERSITY
and the
OHIO ACADEMY OF SCIENCE

THE OHIO JOURNAL OF SCIENCE

ADMINISTRATIVE BOARD

For Ohio State University	For Ohio Academy of Science
LAURENCE H. SNYDER	WARREN P. SPENCER
GEORGE W. WHITE	WILLIAM LLOYD EVANS

EDITORIAL STAFF

GLENN W. BLAYDES	**Editor-in-Chief**
JOHN A. MILLER	**Business Manager**
RALPH H. DAVIDSON	**Assistant Business Manager**

J. B. PARK	Agronomy	J. ERNEST CARMAN	Geology
R. A. KNOUFF	Anatomy	W. H. SHIDELER	Paleontology
H. H. M. BOWMAN	Botany	C. W. JARVIS	Physics
R. C. BURRELL	Chemistry	F. A. HITCHCOCK	Physiology
E. LUCY BRAUN	Ecology	J. P. PORTER	Psychology
F. C. WAITE	Embryology	E. R. HAYHURST	Public Health
G. D. HUBBARD	Geography	R. V. BANGHAM	Zoology
GEORGE M. CURTIS	Surgery Research		

THE OHIO JOURNAL OF SCIENCE

Is published jointly by the Ohio State University and the Ohio Academy of Science.

CONTENTS OF VOLUME XLIII

NUMBER 1—JANUARY

PAGE

The Genetics of Congenital Pyloric Stenosis............*E. A. Cockayne and L. S. Penrose* 1
The Gipsy at the Crucifixion of Christ ....*August C. Mahr* 17
The Ants of Ashtabula County, Ohio (Hymenoptera, Formicidae)......... *A. E. Headley* 22
Life History and Habits of the Cicada Killer in Ohio, *Charles A. Dambach and Eugene Good* 32
A New Chrysobothris (Buprestidae: Coleoptera)........................ *J. N. Knull* 42
Transpiration in American Holly in Relation to Leaf Structure.......... ..*C. A. Swanson* 43
The Effect of pH on Pure Cultures of *Euglena mutabilis*............ ...*Herman Von Dach* 47
Book Notices...16, 41

NUMBER 2—MARCH

Studies in Human Inheritance. XXII. The Inheritance of Congenital Pyloric Stenosis....................................*Laurence H. Snyder* 49
Structure and Relationship of Cincinnatian *Cyrtocerina*........... . *Rousseau H. Flower* 51
Photoperiodic Aftereffects in *Ipomoea*.................... *Victor A. Greulach* 65
Third Annotated List of *Phymata* Prey Records (Phymatidae, Hemiptera)..*W. V. Balduf* 74
A New Genus (*Deltorynchus*) and Two New Species of Leafhoppers (Homoptera, Cicadellidae) from Mexico.......................*Dwight M. DeLong* 79
Staining Inulin Crystals in Plant Tissues.......................*Glenn W. Blaydes* 81
A Device for Observing Living Fish Embryos at Controlled Temperatures, *John W. Price* 83
On Some American and Oriental Earthworms. Part I.................*G. E. Gates* 87
Book Notices.. 50, 64, 73, 86

NUMBER 3—MAY

On Some American and Oriental Earthworms. Part II. Family Megascolecidae, *G. E. Gates* 89
The Mechanism of Heredity in Relation to the Theory of Natural Selection, *W. L. McAtee* 117
Petroleum in Southeastern Ohio.............................*E. Willard Miller* 121
Composition of Fungus Hyphae IV: Phytophthora....... .... *R. C. Thomas* 135
Some Investigations of the Water Relations of Lichens, *Herbert T. Scofield and Lawrence E. Yarman* 139
Book Notices...134, 138, 146

NUMBER 4—JULY

Annual Report of the Ohio Academy of Science.................................. 147
Woods and Trees.......................................*Frederick H. Krecker* 158
The Ants of the Kildeer Plain Area of Ohio (Hymenoptera, Formicidae), *Mary Elizabeth Amstutz* 165
Drosophila Culture with a Minimum of Agar.......................*Warren P. Spencer* 174

PAGE
Records of Anostracan Phyllopods in Northeastern, Ohio, *Ralph W. Dexter and Leslie E. Sheary* 176
Pre-Illinoian Glaciation in Southeastern Ohio............................*H. A. Ireland* 180
An Observed Infestation and Treatment of *Psoroptes cuniculi* in the Ears of Laboratory Rabbits..*John Heffelfinger* 181
An Investigation of the Linkage Relationships of the Blood Groups and Types with Hand Patterns and Handedness...................*D. C. Rife and H. Warner Kloepfer* 182
Additions to the Revised Catalogue of Ohio Vascular Plants. XI........*Clyde H. Jones* 186
Descriptions of the Neotype of *Draeculacephala mollipes* (Say) and a New Species Previously Confused with it...............*Ralph H. Davidson and Dwight M. DeLong* 193
Book Notices..175, 185

NUMBER 5—SEPTEMBER

Varves in Sandusky Bay Sediment..*Ira T. Wilson* 195
Studies in the Biology of the Leech. VI. The Anatomical Basis for Certain Leech Behavior...*John A. Miller* 198
An Ecological Study of the Worm Parasites of Portage Lakes Fishes......*Robert C. Hare* 201
A New Prairie Spider ....*W. M. Barrows* 209
A New Species of Astraeospongia from the Middle Devonian of Ohio.......*John W. Wells* 210
Two New Ulotrichales...*Edgar N. Transeau* 212
Studies of the Genus Empoasca (Homoptera, Cicadellidae). Part X. Fourteen New Species of Empoasca from Mexico..........*Ralph H. Davidson and Dwight M. DeLong* 214
Protozoan Parasites of the Orthoptera, with Special Reference to Those of Ohio. IV. Classified List of the Protozoan Parasites of the Orthoptera of the World. Classes Mastigophora, Sarcodina, and Sporozoa..............*Frank Merrick Semans* 221
Book Notices..200, 208, 211, 213

NUMBER 6—NOVEMBER

Contributions to the Stratigraphy of the Allegheny Series in Columbiana and Mahoning Counties, Ohio. Part I. Stratigraphy and Correlation of the Coals and Limestone Below the Lower Kittanning Coal...*Myron T. Sturgeon* 235
A New Genus (Ascius) and Two New Species of Leafhoppers Closely Related to *Flexamia*. (Homoptera, Cicadellidae)..*Dwight M. DeLong* 250
A Portable Case for Water Analysis in Ecological Field Work.........*William A. Dreyer* 252
Soil Conservation Districts in Ohio.....................................*T. C. Kennard* 257
Buckeye Lake White Bass...*Lee S. Roach* 263
Records of Ohio Dragonflies..............................*B. Elwood Montgomery* 267
Protozoan Parasites of the Orthoptera, with Special Reference to Those of Ohio. IV. Classified List of the Protozoan Parasites of the Orthoptera of the World—(Continued)..*Frank Merrick Semans* 271
Book Reviews...249, 256, 266, 270, 276
Index to Volume XLIII...277

PUBLICATION DATES OF THE OHIO JOURNAL OF SCIENCE FOR 1943

January issue	February 26
March issue	April 12
May issue	May 28
July issue	August 20
September issue	November 2
November issue	December 29

THE OHIO JOURNAL OF SCIENCE

VOL. XLIII JANUARY, 1943 No. 1

THE GENETICS OF CONGENITAL PYLORIC STENOSIS

E. A. COCKAYNE,
Great Ormond Street Hospital, London, England

and

L. S. PENROSE,
Ontario Hospital, London, Canada

Congenital pyloric stenosis is a condition which usually becomes manifest about the fourth week after the patient's birth. The symptom of projectile vomiting with constipation and the signs of pyloric tumor and gastric peristalsis are occasioned by anatomical changes which can only be observed if the case is surgically treated or examined at autopsy. The essential feature of the disease, muscular hypertrophy of the pylorus, is a structural change, probably present before birth for it has been identified in a stillborn child and a seven months' foetus (Strachaner 1927). The disease has a low familial incidence and, though several pedigrees have been published which show more than one affected child, the mode of inheritance is uncertain. Cautley and Dent (1902) reported instances of the disease in a great aunt and her nephew and a family with three affected sibs was mentioned by Heubner (1906). There are other early records of more than one case in a family (Freund, 1903, Grissen, 1904, Ashby, 1907, and Rosenhaupt, 1907). Still (1915) pointed out that in a series of 94 cases there were three pairs of affected sibs and Finkelstein (1924) recorded one family with four and another with three sibs affected. A brother and sister, both affected, whose father may also have had pyloric stenosis in infancy, were described by Caulfield (1926), and Ashton (1929) found an authentic example of mother and son both affected. Cockayne (1934) published two pedigrees, each with a pair of first cousin patients. The case of a male patient, whose brother's son and daughter and whose sister's two sons developed the same condition, was reported by Halbertsma (1935). De Lange (1936) put on record a family of a female patient whose sister's twin sons were also patients. Fabricius and Vogt-Moller (1937) described the case of a normal woman who had three affected children by her first husband and four by her second. Four pedigrees were investigated by Cockayne (1938): in one there was an affected pair of second cousins, in two pedigrees there were pairs of first cousin patients and, in the other family, there was a pair of affected first cousins, of whom the mother of one and the sister of the other suffered from vomiting during the first weeks of life.

Evidence in favor of hereditary influence in the causation of the disease has been obtained from the study of twins. Indeed, Ford, Brown and McCreary (1941) consider twining to be unduly frequent among affected cases. When the twins are binovular, it is usually found that if one is affected the other is normal; except in one instance (Sheldon, 1938) monovular twins are equally affected.

When a series of hospital cases of congenital pyloric stenosis is examined with respect to the birth order of the patients, it is regularly found that between 40 and 60 per cent are the result of first pregnancies: for example, Still (1929) found that

48.5 per cent were first born in 400 cases. The inference that primogeniture is a causal factor has been accepted by many authorities (Ford, Ross and Brown 1941) but not all (Bell and Fitsgibbon, 1934). Since the statistical proof is not easy, a further investigation on this point is not, perhaps, out of place. Pearson (1914), for example, asserted that primogeniture was a cause of quite a number of physical and mental defects: in some cases, later investigators have shown that his conclusions cannot be upheld (Thurstone and Jenkins, 1931). In order to establish beyond doubt that primogeniture is really a contributary cause of a condition, data would have to be collected to show that the children born after the patient were nearly always normal.

In the investigation described in this paper, an attempt was made to follow up, after a period of years, the families of undoubted cases of congenital pyloric stenosis. It was hoped, by this means, to obtain adequate data on which the influence of primogeniture might be accurately estimated. Unfortunately, the birth rate, during the period of the investigation, was declining and the following up of the families only discovered a very small number of brothers and sisters born after the patients. Nevertheless, the results of the investigation, though not absolutely conclusive, are of value in suggesting the probable aetiology of the condition.

The investigation was spread over a period of about five years. Most of the patients, who were the propositi of the study, had been treated in St. Thomas's Hospital, Great Ormond Street Hospital for Children, in London, England. The writers are indebted to a large number of helpers, among whom Miss D. E. Newlyn and Dr. D. M. Kapp should be specially mentioned.

Great difficulties were encountered in following up cases after long intervals. It was originally planned that the average interval between the operation and the visit to the family would be ten years: in fact the average interval was 6.66. The total number of propositi with unpublished pedigrees available for study was 434 but only 212 families were actually visited. Attempts made to visit the families of about 150 patients were unsuccessful. In rural districts, nearly all the families could be traced, but less than half of those who had lived in cities.

In the sibships of the 212 visited families (Series A), there were 221 affected children, of whom 185 were males, and 36 females. The diagnosis was confirmed at operation or autopsy in all cases except ten, eight males and two females, in whom the condition was medically treated. Of the children treated by operation, 130 males and 34 females were surviving at the time of the visit: five males had died of intercurrent diseases. In a number of the surviving cases, some abdominal disability remained, but the great majority appeared to be quite healthy. Of the ten medically treated cases, two males and two females died at the age of four months or under. The propositi, whose homes were not visited, (Series B), numbered 222 and in their sibships were altogether 228 affected children. Of these, 201 were males, 26 females, and one of unknown sex. In all, 386 out of 449 patients were males, i. e., 86.0.

THE GENERAL FEATURES OF THE VISITED FAMILIES (SERIES A)

In the 212 families, whose histories are summarized in the appendix, there were 528 children who were known to be either affected or unaffected (Table I). There were also 53 children, whose state with respect to the disease in question could not be ascertained: of these, 26 miscarried, 13 were stillborn or died at birth, and 14 died in infancy. The average number of children per family in the data is, therefore, less than three. The value of the data for deciding whether or not primogeniture is an aetiological factor depended a great deal on the number of normal or affected children born in the interval between the patient's operation and the visit. This number, 132, was disappointingly small. Some of the parents who were interviewed admitted that they had deliberately limited the family after the patient's operation because of the fear that another child might have to undergo the same treatment.

The familial incidence of the condition is low but the disease is rare enough to make it likely that, if two affected children are found in the same sibship, this is not due to coincidence. In Series A, there were seven families with two children affected (See families Nos. 24, 68*, 119, 126, 167, 188 and 199*) and one family with three children affected (See No. 107). Further evidence of familial concentration was obtained by investigating near relatives. Two pairs of propositi were first cousins of one another (See Nos. 37 and 150, 148 and 164): four other patients each had a cousin affected (See Nos. 31, 63, 104 and 181). In addition to this definite familial incidence, there were doubtful histories of congenital pyloric stenosis in one mother, three brothers, one sister, one uncle and one cousin: for purposes of analysis these were counted as unaffected. In taking the family histories, attention was paid to the incidence of diseases of the alimentary tract, such as peptic ulcer, cholecystitis, peritonitis and cancer of the stomach. Four fathers and four mothers had definite histories of gastric or duodenal ulcer, there were also nine such histories among grandparents and four among patients' uncles. Appendicitis, peritonitis or ulcerative colitis were recorded in 13 parents, three sibs and five grandparents. Nine grandparents died of cancer in the alimentary tract.

TABLE I

SIBSHIPS (SERIES A) WHICH CONTAIN AT LEAST ONE CASE OF CONGENITAL PYLORIC STENOSIS: NUMBER OF CHILDREN

	Born before Propositus	Propositus	Twin of Propositus	Born after Propositus	Total
Affected Male	....	178	2	5	185
Affected Female	....	34	0	2	36
Unaffected Male	90	....	1	73	164
Unaffected Female	88	....	3	52	143
Total	178	212	6	132	528
(Miscarriages, Stillbirths, etc.)	(34)	(—)	(0)	(19)	(53)

There appears to be a slight tendency for patients to possess structural abnormalities other than pyloric stenosis: two patients (See Nos. 20 and 95) had hare lip and cleft palate, and in the family where three sibs were affected (No. 107), all three had abnormal conformation in the premaxillary region. One patient had a congenital heart lesion (No. 54) and one had club feet (No. 190). Mental disease was a rare complication; one subject was an idiot (No. 52), one was an imbecile (No. 104) and two were mentally retarded (Nos. 62 and 189).

Among the members of the families who were believed not to have congenital pyloric stenosis, there were seven cases of hare lip or cleft palate; one father (No. 7), three sibs (See Nos. 7, 74, and 162) and three other relatives. One brother had a congenital heart lesion (No. 90) and a sister in the same family had oesophageal stenosis. One sister (No. 162) had congenital absence of abdominal wall and another (No. 15) was simply stated to have been "deformed." A cousin (See No. 21) died of rectal atresia and another (See No. 168) had congenital intestinal obstruction. Some of these structural abnormalities may have a genetic relationship to congenital pyloric stenosis. The occurrence of blue sclerotics and brittle bones in patient and mother (No. 131) may have been quite unconnected with congenital pyloric stenosis. Very few cases of mental or nervous disease were found among near relatives.

---

*In these families, the affected pair were twins, but whether monovular or binovular could not be ascertained.

The parents in four families (Nos. 12, 75, 129 and 134) were first cousins and in two families (Nos. 56 and 70) they were second cousins. There was an example also of a related case with first cousin parents in family No. 31. This incidence of first cousin marriages among parents of ascertained cases of congenital pyloric stenosis in Series A is significantly in excess of random expectation (Table II).

TABLE II

PARENTAL CONSANGUINITY

	Number with First Cousin Parents	Number with Second Cousin Parents	Total Number
Propositi and their Sibs (Series A)	4	2	221
Other Relatives (Series A)	1	0	4
Totals (Series A)	5	2	225
Expected Totals with Standard Errors	1.37±1.17	0.45±0.67	225
Propositi and Sibs (Series B)	1	1	228
Totals (Series A and B)	6	3	453
Expected Totals* with Standard Errors	2.76±1.66	0.91±0.95	453

*A survey of 34,625 general hospital patients conducted by the Human Genetics Committee of the British Medical Research Council obtained the estimates 0.61% for first cousin parents and 0.20% for second cousin parents.

THE GENERAL FEATURES OF THE UNVISITED FAMILIES (SERIES B)

The 222 propositi in Series B provided some useful supplementary information, though in many aspects incomplete. In these sibships, 353 children were classified as affected or normal: there were also 16 stillborn sibs or miscarriages. Each propositus was, of necessity, the last to be born in the sibship. In six families, a sib was known to have been affected. Five patients had normal twin sibs. One patient suffered from hypospadias and left inguinal hernia in addition to pyloric stenosis and another suffered from achyluric jaundice. An unaffected sib of one propositus had a cleft palate and hare lip. Duodenal ulcer was diagnosed in the father of one patient.

The maternal grandmothers of one male patient were sisters and the parents of another were second cousins. The recorded incidence of consanguinity in the patients in Series B is thus not abnormal.

PRENATAL ENVIRONMENT

The examination of the effect of maternal age in cases of congenital abnormality sometimes reveals the presence of prenatal causes which would otherwise be unsuspected. The mean maternal age at birth for the 221 subjects with congenital pyloric stenosis in Series A was 28.77 years and for 220 subjects in Series B the mean was 27.73 (maternal age was unknown in eight instances in Series B). A reconstruction of the data in Series A, on the assumption that an affected person would be equally likely to occur at any of the maternal ages found in his sibship, yielded the value of 28.06 years for the expected mean maternal age. The difference between the observed and the expected values are not significant and the result does not indicate that maternal age is an aetiological factor here. Paternal age was also found to be normal.

Of 221 cases in Series A, 109 were the results of first pregnancies. In Series B, 141 cases were first born, out of the total number 228. The large percentages of firstborn cases, 49.3 and 61.9 in A and B respectively, support the view that primogeniture is a significant aetiological factor. Caution is needed in accepting such a conclusion, however. In a recent survey of a very large series of births in Liverpool Maternity Hospital, Malpas (1937) showed that the expected proportion of first pregnancies was 46 per cent. It was admitted that the percentage might be unduly high because primiparae are more likely to be delivered in hospital than multiparae. The proportion of firstborn children in the general population depends upon the mean size of the family in the community and this is difficult to estimate. In particular, as Greenwood and Yule (1914) have shown, families selected by the presence of at least one affected member give an erroneous impression of the size of the family in the general population. The average size of sibships so selected tends to be too large. In a recent investigation of the families of mentally defective patients (Penrose, 1938), the number of births, including miscarriages, per sibship in the general community, estimated by the method of Greenwood and Yule, was 3.38. According to this estimate, the expected proportion of firstborn children should be one in 3.38 or 28 per cent: if this estimate is correct, the proportion of cases of congenital pyloric stenosis who are firstborn is significantly high. There are, however, two other factors which have to be considered. Congenital pyloric stenosis is a familial disease and it is one which may cause family limitation as soon as the occurrence of the first case in the family has been recognized. These two factors both tend to increase the proportion of firstborn affected children in the sample.

Suppose, for instance, that the normal number of children, born in a family in the general community, is s. Assume also that a certain congenital disease causes family limitation so that no children are born after the affected member. Let the true proportion of affected to total numbers of children, in families liable to the disease, be r. The proportion (p) of affected children who are first born in the family will be found to be

$$\frac{r}{1-(1-r)^{s}}$$

If, for example, a rare recessive condition causes family curtailment, the value of r is one quarter, p (the proportion of firstborn cases) has the value of 0.57 in a population where the normal sibship numbers two, a value of 0.43 where the normal sibship numbers three, and a value of 0.37 where the normal number is four children.

The mean size of family in the general population is not far above three and the known percentage of firstborn cases of congenital pyloric stenosis is about 0.50, this proportion would be of the right magnitude to agree with observation if the familial incidence (r) of congenital pyloric stenosis were about three-eighths. The evidence from the families investigated does not suggest that the manifest familial incidence can be nearly as high as this. By following up the 212 cases in Series A, who were the earliest affected in their sibships, 125 unaffected and seven affected children were ascertained (Table I). The propositi had four unaffected and two affected twin sibs. In Series B, there were five normal twin sibs of patients, 120 normal and six affected other sibs. It does not seem likely, therefore, that the manifest familial incidence can be far from one in twenty.

The ideal analysis of the comparative susceptibilities of the firstborn, second born, etc., to congenital pyloric stenosis could be carried out if all the families, in which a case had occurred, were investigated about 20 years after the birth of the propositus. When the time interval between diagnosis and investigation is short, most of the cases are last born children and it is impossible, by the Yule-Greenwood method, to demonstrate any tendency for firstborn children to be affected. Instead of finding an excess of the observed number of affected firstborn over the expected number, when the interval is short, the method reveals a deficit. In the analysis of the present data, this deficit was seen unless the interval exceeded six years. In those families, which were investigated eight years or more after the birth of the propositus, there was a slight excess of the observed number of firstborn affected over expectation (Table III). The only way to obtain an idea of what the analysis would have revealed if the interval could have been longer was to extrapolate. This was feasible because the regression of size of family on length of interval since birth of affected child was found to be linear. If the average interval had been 10 years, the observed number of affected firstborn divided by the expected number of affected firstborn would have been 1.12. If the average interval had been 15 years, the ratio might have risen to 1.59 and, at 20 years, it might have risen to 4.45. Corresponding ratios were calculated for the second and third places in the family and for the fourth to the ninth. In Table IV, the results of these calculations are shown. As no children are likely to be born more than 20 years after the birth of any propositus, the ratios in the bottom row of Table IV show the upper limit of the estimates for relative susceptibilities to congenital pyloric stenosis of children in the different birth ranks. The firstborn is perhaps about twice as likely to be affected as any child born afterwards, but is not more than six times as prone.

TABLE III

Number of Years Since Birth of Propositus	Number of Cases	Number of Cases which Result from First Pregnancies	
		Observed	Expected
0- 6	90	48	54.62
7	58	26	25.96
8-13	73	35	30.76
0-13	221	109	111.34

DISCUSSION ON THE MODE OF INHERITANCE

Two facts have been elicited by this enquiry. In the first place, there appears to be a definite familial incidence, which applies mainly to sibs and to cousins and which is small in magnitude. Secondly, the proportion of the patients with consanguinious parents exceeds random expectation. These facts taken together give reason for supposing that congenital pyloric stenosis is partly caused by a recessive Mendelian factor. Analysis of the data on the question of birth order is not conclusive but lends support to the assumption that the firstborn child is more likely to be affected than are the members of the sibship born later. Thus, the low familial incidence observed is not inconsistent with the hypothesis that the underlying causal factor is a recessive gene. A rare recessive trait should, indeed, be manifested in one quarter of the children in families which are prone to the disease. The observed familial incidence here, however, is only about one in twenty. If the firstborn were much more likely to be affected than other children, the familial incidence would be much lower in large families than in small ones. This in fact, is the case in the present data. In Series A, apart from the two sets of affected twins, which are second born, in every family where more than one child is affected, one of them is firstborn. In the data of Series B, there are three instances of first and second, one of first and third, and one example of third and sixth children affected. The tendency to familial incidence is greatest at the beginning of the family. These considerations make it possible for a low familial incidence to be consistent with recessive diathesis as the underlying cause.

In the present data, as in previous work, a great excess of male over female patients is found: the males are about six times as numerous as the females. Among the unaffected sibs in Series A, however, the males exceeed the females, namely, 164 males to 144 females; in Series B there were 51 normal male sibs, 57 normal female sibs and 17 of unknown sex. Thus there were altogether 215 male and 201 female normal sibs. This distribution does not favor the assumption that the excess of male patients is due to the action of sex linked genes. Moreover, inspection of pedigrees shows that transmission to a male patient must frequently take place through the father. There is also no evidence of partial sex linkage. It seems correct to assume that the male constitution has less resistance than the female constitution to the development of the disease. This explanation of the differential sex incidence helps to account for the low familial incidence observed.

TABLE IV

RATIOS OF OBSERVED TO EXPECTED NUMBER AFFECTED IN DIFFERENT BIRTH RANKS

The table is calculated upon the assumption that the increase of size of family with the lapse of time is linear.

Number of Years Since Birth of Propositus	Birth Rank		
	1st	2nd to 3rd	4th to 9th
0	0.82	1.17	6.19
5	0.93	0.96	1.72
6.66*	0.98	0.92	1.46
10	1.12	0.85	1.17
15	1.69	0.78	0.95
20	4.45	0.74	0.84

*Mean interval in the data.

On the hypothesis that a rare recessive gene is the underlying cause, the chance that any child is susceptible in a sibship, where the disease can occur, is usually one in four. If the degree of susceptibility of the firstborn male child is maximal, the chance of its being affected is one in four. The degree of susceptibility of a firstborn female or of a male not firstborn will be much less than this, and the female who is not firstborn stands very little chance of being affected. The manifest familial incidence of the disease in a family of three children, which mainly depends upon the chance of the occurrence of an affected firstborn male, will have a value not much greater than ¼ times the chance of being a male times the chance of being firstborn, i. e., ¼ x ½ x ⅓ or 1/24. The observed familial incidence of 1/10 is thus not in disagreement with the view that the predisposition has a familial incidence of ¼. The gene, moreover, must be commoner than the frequency of the disease in the general population would at first suggest. Hence, it is not unlikely that occasionally parent and child would both be affected.

The hypothesis that a recessive gene, whose manifestation is influenced by birth order and sex, is the cause of congenital pyloric stenosis can be used to interpret the presence, in certain families, of abortive cases and associated abnormalities. Some structural abnormalities found in patients may have been accidentally present, but others, like hare lip, cleft palate and intestinal atresia, may have been modified manifestations of the same underlying gene. It is conceivable, also, that some of the alimentary diseases in relatives may have been manifestations of the gene in the heterozygous form. Peptic ulcer, for example, like congenital pyloric stenosis, is more often found in males than in females and has been believed to be due to an irregularly dominant genetic factor (Levin and Kucher, 1934). In homozygous form, this factor might affect the same organ more severely and earlier in life. In support of this view, it may be recalled that ulcers of the duodenum associated with pyloric stenosis in infants have been recorded by several observers (Holt, 1913; Harrison, 1931).

SUMMARY

The families of 212 cases of congenital pyloric stenosis were investigated about 6½ years after the births of the propositi. In this way, nine more cases were discovered in the sibships, two of whom were twins of the propositi. The data were amplified by reference to 222 propositi whose families were not visited. The data are consistent with the hypothesis that the disease is a recessive diathesis. Males are more susceptible than females and the firstborn child is more susceptible than children born afterwards in the same sibship. The relationship of congenital pyloric stenosis to some other diseases is discussed.

APPENDIX

DETAILS OF 212 SIBSHIPS: SERIES A

N—Identification number of sibship.
A—Number of years between birth of first affected child and date of investigation.
B—Excess of father's age over mother's age.
C—Order of birth in sibship. The sex and maternal age at birth of each sib is shown in the appropriate birth rank. Affected children, who were living at the time of investigation, are indicated by underlining once. Affected children, who did not survive, are marked by double underlining.

All cases were surgically treated, except those marked thus: *.

Additional notes on the sibships can be found by reference to the identification numbers.

N	A	B	C 1	2	3	4	5	6	7	8	9	10
1	2	1	$\underline{\text{F 30}}$									
2	5	5	F 21	F ..	M25	M27	M29	$\underline{\text{M30}}$	M33			
3	1	2	.	$\underline{\text{M31}}$								
4	6	2	$\underline{\text{M24}}$									
5	3	0	M19	$\underline{\text{M22}}$								
6	5	2	$\underline{\text{M22}}$									
7	7	1	M25	$\underline{\text{M27}}$	F 31	M33						
8	2	1	M28	$\underline{\text{M35}}$								
9	2	?	$\underline{\text{F 23}}$									
10	4	4	F 23	$\underline{\text{M24}}$	F 27							
11	9	0	F 21	F 23	$\underline{\text{M27}}$							
12	5	2	$\underline{\text{M27}}$									
13	5	10	F 23	$\underline{\text{M27}}$								
14	2	0	$\underline{\text{F 18}}$									

N	A	B	C									
			1	2	3	4	5	6	7	8	9	10
15	2	—1	F .	F 27 . .	M30 F 30							
16	11	0	M. .	M39								
17	4	0	M17	M19	F 24	M26	.	F 28	F 31	M33		
18	13	10	M19	F 22	M23	F 25	F 26	F 29	F 31	F 33		
19	2	6	M29	. .								
20	0	7	M28									
21	2	1	M38									
22	9	0		F 29	M30							
23	5	0	M27	F 30								
24	5	0	M20	M22								
25	5	—2	M29	M32	F 41							
26	4	2	M23	M25								
27	4	5	F 32	M34								
28	9	1	F .	M33								
29	1	0	M29									
30	4	1	M29	M35								
31	1	3	M27									
32	10	—3	F . .	. .	M29	M35						
33	7	6	M22									
34	10	4	M23	F 24	M26	M33						
35	1	6	M29									
36	10	10	F 32	M33	M38							
37	2	7	M26	F 30	M39							
38	3	2	F 22	M25	M27							
39	2	—3	M28	M32	F 34	M35	M37	F 42	M44			
40	7	2	M38									
41	8	—1	F 25	M26	F 29	M31	M32	F 38				
42	8	5	M22	F 24	M27	F 31						
43	11	10	M22	F 24	M26	M28	M30	M34	M37			
44	5	4	F 29	M33								
45	3	3	M25									
46	3	2	M25									
47	12	12	F 29	F 32								
48	6	8	M22	F 24								
49	4	1	M26									
50	4	2	M22									
51	5	7	M21	25								
52	3	3	M29									
53	9	—1	M27	M32								
54	3	1	M25									
55	8	—1	M24	M27								
56	5	—1	F 25	M29								
57	8	—3	M33	M36								
58	10	10	M25									
59	8	5	F 28	F 31								
60	6	3	M24	F 27	M31							
61	6	10	F 41									
62	7	6	M34									
63	6	4	F 26	F .	F 29							
64	7	—2	F 29									

N	A	B	C									
			1	2	3	4	5	6	7	8	9	10
65	6	0	F .	M21	M25							
66	7	—6	M28	F 29	M31	F 35						
67	7	—?	M29	M31								
68	7	1	M21	M22 M22								
69	6	17	F 28									
70	7	1	F 29	M33	M35							
71	7	19	M28	M29	M32							
72	2	0	M28									
73	8	5	F 31									
74	6	7	M22	F 25								
75	7	1	M27	M28	M32							
76	6	10	F 34	M36	F 38	M43						
77	7	1	M26	M28	M31							
78	6	5	F 24	F 26	F .	M29	M30					
79	8	2	F 26	M29								
80	8	3	M22	F 24								
81	8	1	M23									
82	7	1	F 19	F 22	M28	M34						
83	8	1	F 20	F 26	F 27	M29	F 31	M35	M37	M38	M40	. . . .
84	7	2	M30	M33	M37							
85	9	3	M21	F 23	M27	M30						
86	7	0		M31	F	M38						
87	8	4	M28	F 29	F 32							
88	7	3	M23	M28	. .							
89	7	2	M23	F 27								
90	7	0	M F 29	M34								
91	7	5	F 34	M36	M							
92	7	9	M19	F 25								
93	7	—1	M26	M28								
94	6	7	F 32	F 33	M34	M39						
95	8	—3	M33		M38	M39						
96	6	0	F 23	M29	F 32	F 37						
97	6	5	F 17	M19	M24	M27						
98	6	1	M31									
99	7	—4	M33	M34	. .							
100	6	0	M21	F 24								
101	7	2	M21	M25	M29							
102	7	3	F 22	F 27	F 29							
103	6	3	M25									
104	7	2	F 24	F 25		F 33						
105	6	10	F 23	F 28								
106	7	7	F 25	M26	F 29	F 31	M33					
107	10	4	F 24		M27	F 29	. .					
108	7	—2	M38									
109	7	—4	F .		M36							
110	7	1	F 30	M32								

N	A	B	C									
			1	2	3	4	5	6	7	8	9	10
111	6	—2	M32									
112	7	2	....	M35	F 39							
113	6	7	F 32	F 34								
114	6	0	M40	F 44								
115	6	1	F 26	M30								
116	5	1	M27									
117	7	9	F 23	F 24	F 27	M29	F 34					
118	7	2	M21	M23	F 25	F 30						
119	7	1	M22	M23	M26							
120	8	0	F 25	M27								
121	8	—6	M31									
122	6	0	M24	M27								
123	7	—1	F 23	F 26								
124	7	0	F 31	M38	F 40							
125	7	0	M20	F 26	F 29	M30	M32					
126	8	6	M23	M24	M26							
127	7	20	M39	F ..	{							
128	10	—2	M28									
129	7	5	M22									
130	10	—3	M33									
131	7	12	....	F 38								
132	10	0	F 25	M27								
133	8	—2	....	F 34	F 38							
134	10	0	F 33	M34	F 38							
135	10	—3	F 24	....	M31							
136	7	0	M28									
137	7	0	M23	F 26								
138	7	7	M29	M31								
139	7	—6	M32	F 34	F 36	....	F 39	M41				
140	10	0	M23									
141	7	1	F 24	M26								
142	7	1	M28	M31	F 38							
143	7	4	M31	M37								
144	7	—3	M26	M27								
145	10	2	M19	M26								
146	10	3	M23	F 24	M26	M28	F 30	M32	M34	M35	M38	
147	6	—2	M30									
148	4	—1	M23	M27								
149	5	4	M25									
150	7	3	M34									
151	8	3	F 25	F 27	M33							
152	7	1	M23	M25	M27	M30						
153	8	4	M25	M28	M31							
154	9	1	M23	M26	M28	M31	M34	....	M37			
155	5	5	M21	M27								
156	6	3	M19	....								
157	7	—1	M24	F 30								

N	A	B	C 1	2	3	4	5	6	7	8	9	10
158	8	0	M23	M25	M27	F 29	M31	M32	F 34	. . . .		
159	5	8	M21	M30	M31							
160	7	—5	M30	F 31	M34	M37						
161	8	6	M22	F 29								
162	6	4		F	M28	M31						
163	8	1	M23	M25	M33							
164	7	0	M24	M30								
165	8	—1	M30	F 32	F . .	F 36	M38	F 40				
166	6	13	M20	F 22	F 23	F 27	.	M34	M37			
167	13	2	M32	F 33	.							
168	10	4	M24	M27								
169	?	?	. .	M34								
170	6	3	M23	M25								
171	4	8	M18									
172	4	1	M25	F 26	M30	M35						
173	4	3	F 28	M32								
174	4	6	M22	F 26								
175	11	0	M25	M27	M28	M29	. .					
176	4	3	M16	F 18								
177	6	6	M25	M27								
178	6	2	M26									
179	7	1	F 31	F 35								
180	11	—1	F 22	M24	F 25	M28	F 30					
181	8	—2	F 28	M30	M39							
182	11	—7	M41	.								
183	9	23	M22	M M .	M24	M26	F 28	M33				
184	8	—1	M29	M35								
185	11	4	M26 F26	F 29	M33 F 33							
186	8	0	F 19	F 22	M24	M27	F 29	F 32	F 34	F 36		
187	8	4	M17 F 17	M19								
188	13	4	M19	F 23	M27	M29						
189	10	3	M21									
190	6	1	M22									
191	9	—8	M37									
192	3	7	M23	M24	M26	F 28	F 33	M35				
193	7	—1	M28									
194	8	—5	M33	F 34								
195	11	—2	M31	F 33								
196	2	5	M22									
197	5	8	M21	M22								
198	9	4	F 20	M22	M25	M29						
199	7	3	F . .	M28 M28	F 34							
200	11	1	M	M26	F 27							
201	4	3	M20	M22	M26	M34	.					
202	6	1	M27 M27									

N	A	B	C									
			1	2	3	4	5	6	7	8	9	10
203	2	2	F 30	M35*								
204	1	1	F 22	M33*								
205	1	—2	M28*									
206	2	7	M25	....	....	M28*	F 29					
207	8	2	M25*									
208	9	1	M24*	F 27								
209	6	1	F 28*	M29								
210	9	4	M25	M26*	M28	M30						
211	10	1	F 35*	M37								
212	10	0	M22*	M23	F 25							

NOTES

2. C2—died at birth. Two sisters of mother—cleft palates.
3. C1—miscarriage at 4 months.
5. C1—died of measles at 10 months. Mother's cousin—Little's disease.
7. Father—cleft palate. C1—double hare lip.
9. Mother—history of vomiting in early infancy.
12. Father and mother—first cousins.
15. C1—stillborn, "deformed." C2—one twin died at one year of diarrhoea and vomiting.
16. C1—stillborn.
17. C5—miscarriage at 3½ months.
19. Mother—appendectomy at 19. C1—died at 7 weeks. C2—miscarriage at 1 month.
20. C1—hare lip and cleft palate, died at 4 weeks.
21. Mother's sister's son died at 1 week of atresia of rectum.
22. C1—miscarriage at 2 months.
27. Mother's mother—haemorrhage due to gastric ulcer.
28. Father—died at age of 40 of ulcerative colitis. C1—died at 1 day.
30. Father—appendectomy at 32. Mother—appendectomy at 31. C2—undescended testis.
31. Two children of 2 sibs of one of the father's grandparents were the parents of a male who was medically treated for pyloric stenosis.
32. C1—stillborn. C2—miscarriage at 3 months. Father's mother—died of cancer of the stomach.
36. C2—infantile paralysis at 14 months. C3—hemiplegic, but no history of febrile attack.
37. Father's sister's son—No. 150, C1.
38. Mother's mother—cholecystectomy.
39. Father's sister—cholecystectomy.
40. Mother—gross rachitic deformity. C1—born by caesarean section.
41. C1, C2, and C6—died of measles in infancy.
42. Mother's brother's son—medically treated for severe vomiting at 3 months.
45. Father—appendectomy at 28. Father's brother—died of cancer of the stomach.
46. Mother's brother—medically treated for severe vomiting in infancy.
49. Father—abdominal tuberculosis. Father's mother's father—died of cancer of rectum two children of his sibs died of cancer of stomach.
51. Father—pulmonary tuberculosis.
52. C1—idiot with small head.
54. C1—congenital heart lesion.
55. Father's father—died of cancer of stomach.
56. Father's mother and mother's father—first cousins. Father—duodenal ulcer; appendicectomy at 32. Father's mother—perforated gastric ulcer.
58. C1—hydrocoele at 2 years. Father's father—died of cancer of the oesophagus.
60. Mother—slight exophthalmic goitre.
61. Mother—duodenal ulcer at 42.
62. C1—mentally retarded.
63. C2—died at 2 months. Father's brother's son—treated medically for pyloric stenosis.
64. Mother—slight goitre.
65. C1—stillborn.
68. C2—both twins died at about 2 months.
70. Father's father and mother's father—first cousins. Mother—appendicectomy at 39.
71. C1—died at 10 weeks.
74. C2—hare lip. Father's father—gastrectomy for ulcer.
75. Father's father and mother's father—brothers. C1—died at 10 weeks. C2—recurrent vomiting from 2 to 5 years.

76. C2—died at 8 weeks.
77. C1—died of diphtheria at 5.
78. C3—"died at birth."
81. C1—died at 9 weeks.
82. C3—died of diphtheria at 4.
83. C2—appendicectomy at 14. C3—pulmonary tuberculosis. C4 and C5—died of diphtheria in childhood. C1—miscarriage. Father's father—died of cancer of the bowel. Mother's sister—cancer of the stomach.
84. C2—died at 8 weeks.
85. C1—died at 7 weeks.
86. C1—died at 2 months. C2—appendicectomy at 11. C3—died at 4 months of gastroenteritis.
87. C1—died at 8 weeks.
88. C3—stillborn.
89. C1—died at 11 weeks.
90. C1—male twin died at 6 weeks of congenital heart. C2—died at 2 months. C3—died at 3 days of oesophageal stenosis.
91. C2—died at 13 weeks. C3—died at one month.
93. Mother—dyspeptic. C1—died at 8 weeks. Mother's brother—two operations for gastric ulcer.
95. C1—hare lip and cleft palate, died at 11 weeks. C2—stillborn.
97. Father—dyspeptic.
98. Father had attacks of abdominal pain.
99. C2—appendicectomy at 2 years. C3—induced abortion. Mother's sister—appendicectomy.
100. Father—appendicectomy at 23 years.
101. C3—hernia.
103. Mother—appendicectomy at 30. Mother's brother—appendicectomy.
104. C3—miscarriage. C4—imbecile with subthyroidism. Father's brother's son—congenital pyloric stenosis.
105. Father—duodenal ulcer at 40; perforated gastric ulcer at 43. Mother's brother—died of peritonitis.
106. C2—died of lymphosarcoma of thymus at 11. C5—died at 8 weeks.
107. Mother—appendicectomy at 30. C2—miscarriage at 3½ months. C5—miscarriage at 5½ months. C1, C3, and C4—very slight degree of cleft palate in each case. Father's father—died of cancer of stomach.
108. C2—miscarriage at 4½ months.
109. C1—died in convulsions at 4 days. C2—miscarriage at 3 months. Mother's mother—cholecystitis.
110. Mother—duodenal ulcer at 36.
111. Two of mother's nephews—appendicectomy.
112. C1—miscarriage. C2—died at 15 weeks. Mother's mother—died of cancer of stomach.
113. Mother—appendicectomy at 28; probably also gastric ulcer. Father's father—died of carcinoma of colon.
114. Father—chronic colitis. C1—died at 8 weeks. Mother's mother—died of cancer of stomach.
118. Mother—gastric ulcer at 16. C2—died at 9 months. C3—epileptic.
119. Father's mother—cholelithiasis. Father's mother's brother—hare lip.
120. Mother—umbilical fistula.
122. Mother's mother—gastric ulcer.
124. Father—appendicectomy at 40. C2—died at 7 weeks.
125. C4—died at about 2 months.
126. C1—died at 6 weeks. Father's brother—cancer of stomach. Mother's mother—duodenal ulcer.
127. C1—died at 6 weeks. C2—stillborn. C3—miscarriages. Mother's sister's daughter—died of appendicitis at 11.
129. Father's mother and mother's mother—sisters.
130. Mother's sister—gastric ulcer at 30.
131. Mother—bluish sclerotics: one tibia curved. C1—miscarriage. C2—blue sclerotics and brittle bones.
134. C2—died of diphtheria at 3½. Father's father and mother's father—brothers.
135. C2—stillborn. C3—died at 6 weeks.
136. C1—died at 9 weeks.
137. Father's sister—died of peritonitis at 17.
138. Mother's mother—died of subphrenic abscess.
139. C4—stillborn. C6—died at 13 weeks.
140. C1—died at 5 weeks.
141. C2—died at 10 weeks.

143. C1—died at 9 weeks.
145. Father's brother's son—peritonitis. Mother's brother—died of intussusception at 4.
146. C7—died at 6 months.
148. Father's sister's son—No. 164, C2. Mother's mother—gastric ulcer at 47.
149. C1—died at 11 weeks.
150. Mother's brother's son—No. 87, C3.
154. C3—died at 3 months. C6—miscarriage.
156. C1—died at 8 weeks. C2—miscarriage.
158. C8—miscarriage at 6 weeks. Father's mother—died of cancer of bowel.
159. C2—died at 4 weeks.
162. Father—pyloric ulcer at 32. C1—miscarriage. C2—abdominal wall malformed, died at 3 weeks. C4—abortive hare lip and cleft palate.
164. Mother's brother's son—No. 148, C1.
165. C3—stillborn.
166. C5—miscarriage.
167. C3—stillborn. Father's sister—appendicectomy.
168. Mother—appendicectomy at 14. Father's nephew or niece (whose parents were first cousins)—died of congenital intestinal constriction.
169. Mother—duodenal ulcer. C1—miscarriage. Mother's father—died at 67 of gastric ulcer.
170. Mother—hyperemesis gravidarum ar 24. C2—died at 4 weeks.
172. C4—died at 3 weeks.
175. C5—miscarriage.
176. C1—died at 4 months.
177. Father—exophthalmic goitre at 22. Father's brother—gastric ulcer.
178. C1—died at 9 weeks.
179. C1—died at 6 weeks.
180. C4—died of meningitis at 9 months. Mother's father—died of perforated ulcer in alimentary tract. Mother's mother—gastric ulcer. Mother's brother—duodenal ulcer.
181. Mother—goitre. Mother's brother's daughter—pyloric stenosis, medically treated. Mother's father—died of duodenal ulcer.
182. C1—died at 7 weeks. C2—miscarriage.
183. C2—one twin died at 2 months, the other at 2 days.
184. C1—hernia.
185. C1—died at 7 weeks.
186. Father—severe dyspepsia.
187. Mother's father—gastric ulcer.
188. C4—hernia.
189. C1—mentally dull.
190. C1—talipes.
192. C3—tuberculous peritonitis.
197. C1—died at 9 weeks.
198. C1—died at 9 weeks.
199. C1—died at 3 days. Father's sister—dyspeptic.
200. C1—died of wasting disease at 3.
201. C4—died at 10 weeks.
206. C2—miscarriage at 3 months. C3—miscarriage at 1 month.
209. C1—died at 4 months.
210. C2—died at 7 weeks.
211. C1—died at 3 months.
212. C1—died at 7 weeks.

REFERENCES

(1) **Ashby, H.** 1907. Lancet, 1: 429.
(2) **Ashton, L. O.** 1929. Arch. Pediat., 46: 651.
(3) **Bell, A. D. C., and FitzGibbon, G. M.** 1934. St. Thomas's Hosp. Rep. London.
(4) **Caulfield, E. J.** 1926. Amer. Jour. Dis. Ch., 32: 706.
(5) **Cautley, E., and Dent, C. J.** 1902. Lancet 2: 1679.
(6) **Cockayne, E. A.** 1934. Lancet, 1: 898.
(7) **Cockayne, E. A.** 1938. Arch. Dis. Ch. 13: 249.
(8) **De Lange, C.** 1936. Arch. Dis. Ch. 11: 39.
(9) **Fabricius, E., and Vogt-Möller.** 1937. Hospitalstidende, 80: 166.
(10) **Finkelstein, H.** 1924. Lehrbuch der Sauglingskrankheiten, Berlin. 690.
(11) **Ford, N., Brown, A., and McCreary, J. F.** 1941. Am. J. Dis. Ch. 61: 41.
(12) **Ford, N., Ross, M. A., and Brown, A.** 1941. Am. J. Dis. Ch. 61: 747.
(13) **Freund, W.** 1908. Centralbl. f. d. Grenzgeb. d. Med. u. Chir. 11: 309.
(14) **Greenwood, M., and Yule, G. U.** 1914. J. Statist. Soc. 77: 179.
(15) **Grissen, H.** 1904. Deutsch. Z. f. Chir. 75: 107.
(16) **Halbertsma, T.** 1935. Maandschrift v. Kindergeneesk. 5: 24.

(17) **Harrison, L. P.** 1931. Arch. Dis. Ch. 6: 245.
(18) **Heubner, O.** 1906. Therapie d. Gegenwart. 47: 433.
(19) **Holt, L. E.** 1913. Am. Journ. Dis. Ch. 6: 245.
(20) **Levin, A. E.,** and **Kucher, B. A.** 1934. Proc. Med. Biol. Inst. Moscow. 3: 148.
(21) **Malpas, P.** 1937. J. Obstet. Gynaec. 44: 434.
(22) **Pearson, K.** 1914. On the Handicapping of the First-Born, London.
(23) **Penrose, L. S.** 1938. Med. Res. Co. Spec. Rep. Ser. No. 229. London.
(24) **Rosenhaupt, H.** 1907. Wein. klin Wochenschr. 20: 1160.
(25) **Sheldon, W.** 1938. Lancet. 1: 1048.
(26) **Still, G. F.** 1915. Common Disorders and Diseases of Childhood. London, 152.
(27) **Still, G. F.** 1929. Lancet. 2: 795 and 853.
(28) **Strachaner, A. C.** 1927. Annals of Surgery. 167.
(29) **Thurstone, L. L.,** and **Jenkins, R. L.** 1931. Order of Birth, University of Chicago Press.

California Geology

This book is an attempt to interpret and make interesting for the general reader the technical knowledge of the complex geology of California.

The first three chapters are introductory, the author going to even greater lengths than a Chamber of Commerce in extolling the wonders of the Golden State. In the next four chapters the reader is oriented by following an 800-mile bee-line the length of the state, by considering the general behavior of rivers and the geologist's time-scale concept, and by having a "panoramic review" of the major events and processes in California's geologic history. Twelve more chapters deal each with a particular area. Three additional chapters consider petroleum, gold, and agriculture. The final chapter is 87 pages long. It conducts the reader along eight different automobile tours selected so as to completely cover the state. Geological phenomena to be seen along each tour are described. There are 108 illustrations, mostly photographs. All the photographs are excellent. Good maps of several of the areas discussed are provided, but this reviewer made considerable use of a large scale map showing the whole state. Such a map, marked so as to supplement the text and folded into a pocket in the rear cover, would have been a decided asset to the book. A glossary with 100 terms and a bibliography with 76 entries are compiled.

Three errors of fact were noted: (1) The lowest point in the continental United States is not—296 feet in elevation with respect to sea level as stated in four places in the book, but is—280 feet as stated on page 1; (2) The San Gabriel Range is *lower* than the San Bernadino Range (page 229); (3) Bumpas' Hell and Chaos Crags lie at the foot of *Mt. Lassen*, not Mt. Shasta (page 321).

The book is quite wordy and often objectionably repetitious. However, a vast store of technical information has been presented in non-technical style. The book should be of exceeding interest to those who enjoy understanding the out of doors, especially those who have had the opportunity to travel in California. It will be of great value to those unfortunates who are still merely planning such travel.—*E. F. Paddock.*

Adventures in Scenery, by Daniel E. Willard. The Jaques Cattell Press, Lancaster, Pa., 1942, 438 pp. $3.75.

Chemistry of Insecticides and Fungicides

Because of rapid progress in the chemical control of insects, it is important to keep abreast of new developments as well as to have a grasp of previous work on the subject. Since such information is usually found in widely scattered publications it is always a great help to fellow workers in a field to have such information assembled into one volume. The author of the book does this in an authoritative manner, because he has taught a graduate course on the subject for several years and the volume is an outgrowth of his notes used in that course. It is the most up-to-date book on the subject and is exceptionally complete in details on the various topics.

The contents by chapters are as follows: Introduction; The Arsenicals; Lead Arsenate; Fluorine Compounds and Miscellaneous Stomach Poisons; Nicotine and Pyrethrum; Rotenone and Miscellaneous Contact Poisons; Sulfur and Inorganic Sulfur Compounds; Oils, Fumigants; Copper Compounds; Mercury Compounds and Miscellaneous Fungicides; Wetting, Spreading, and Emulsifying Agents; Spray Residue Removal; Macro Methods; Micro Methods.

Except for the chapters dealing with macro and micro analytical procedures, the discussions of each chemical compound or group of chemicals is in regard to its sources, toxicity, manufacture, reactions with other insecticide and fungicide mixtures, action to plants and possible corrective measures. A selected list of references is included at the end of each chapter. A subject and author index are appended.

The book is a very worthwhile contribution and wide acceptance appears assured, not only by entomologists and plant pathologists, but also by horticulturists, and teachers and research workers in closely allied fields of science.—*Ralph H. Davidson.*

Chemistry of Insecticides and Fungicides, by Donald E. H. Frear. 300 pages. D. Van Nostrand Company. New York, 1942. $4.00.

THE GIPSY AT THE CRUCIFIXION OF CHRIST[1]

AUGUST C. MAHR
The Ohio State University

Not so long ago, I came across the scenario of a 13th Century cyclical Passion Play, in Greek, from the Island of Cyprus (1). It is the earliest known attempt at a complete cyclical dramatization of the events of Holy Week. Starting with The Awakening of Lazarus, it embraces all the stations of the Passion, Crucifixion, and Resurrection of Jesus Christ, and concludes with the Lord's Injunction to His Apostles.

In general, this *Cyprus Passion Cycle* follows closely either the Greek New Testament, or the apocryphal Gospel of Nicodemus, and only in a few exceptional instances the homilies and similar authoritative sources. In other words, it represents throughout the accepted traditions of the Greek Orthodox Church of the period.

In view of such faithful adherence to the sacred traditions of the Church, one is perplexed by two stage directions in the scene that dramatizes Christ's Crucifixion and the Deposition from the Cross. The first of these acting directions reads: "And when they come to the place, the Smith shall appear and shall crucify Him, and the two thieves, one on the right hand, and the other on the left." The second reads, as follows: "And instantly the Smith shall come, and the Deposition from the Cross shall take place."

The two passages quoted do not employ the same Greek term for "Smith"; in the latter passage, "smith" corresponds to the classical Attic *chalkeus*, while in the former, it is a rendition of the Neo-Hellenic *komodromos*. Whereas the ancient word *chalkeus* is derived from *chalkos*, meaning, successively, "copper," "bronze," and "metal" (particularly, "iron"), the more recent term, *komodromos*, has no primary meaning connected with metal-working; basically, *komodromos* means "one who runs about the village." The famous 17th century Greek lexicon of DuCange (2) lists two meanings: "vagabond," and "itinerant metal-worker." In a footnote to his edition of the Scenario of the *Cyprus Passion Cycle*, the Byzantinist, Albert Vogt, of Geneva (Switzerland), remarks about this *komodromos: En réalité, ce personnage est un bohémien* ("In reality, this character is a Gipsy") (3). Unfortunately, Vogt fails to substantiate this interesting statement.

Until this day, the vagabonding metal-workers, especially the nail-smiths, in the Near East, as well as in the Balkans and the Greek Islands, including Crete, Cyprus and Rhodes, have been Gipsies; and, as the chronology of the Gipsy migrations shows, it is fully justifiable to assume the presence of Gipsy smiths on the Island of Cyprus, in the 13th Century, when the Passion Cycle originated.

Conclusive studies of the migrations of the European Gipsies were published, between 1872 and 1880, by the late Franz von Miklosich, of Vienna (4). He based his research on the fundamental discoveries about the provenience and structure of the Gipsy language, published, in 1844, by the German philologist, A. F. Pott (5). Miklosich analyzed the vocabulary of the Gipsy groups in the different countries of Europe and thus traced the migrations of these tribal units from the East to the West. He showed that all the Gipsies in the world share a common stock of basic words from some Hindi dialect, augmented by a considerable number of Persian words. Hence he drew the inference that their homeland was India—the particular basic dialect points to the Hindukush Mountains—and that from here they first turned to Persia. The presence of a vast amount of

---

[1] Read before the Anthropology Section at the 1942 meeting of the Ohio Academy of Science.

Greek roots in the dialects of all the Gipsy groups of Europe, and the absence of such Greek elements from the Gipsy dialects in Palestine, Egypt and North Africa, indicates that, after leaving Persia, the Gipsy people continued its migration in two columns: one following a southerly course toward Syria and Africa; and the other turning into Asia Minor and subsequently, with the Ægean Islands as stepping-stones, into the Greek mainland, in particular, the Peloponnesus. There is ample documentary evidence that they must have been living in Greece for about two hundred years when, from about 1400 A. D. onward, they began to appear in ever increasing numbers in Hungary, Bohemia, Germany, and all the rest of Europe, including the British Isles.

Although the chronology of their migrations preceding their arrival on the Greek mainland, about 1200 A. D., has not yet been clearly established, surely the afore-mentioned split into a west-bound and a south-bound column must have occurred at least another two centuries previously. Regardless of whether the Gipsies of Cyprus had branched off from the west-bound or the south-bound column, it is certain that, in the 13th Century, they must have been at home on the island for a long time. Since, moreover, the making of nails and other small ironware is an occupation common to both columns, the *komodromos* of the *Cyprus Passion Cycle* may be safely claimed as "a Gipsy nail-smith."

Indirectly, this inference is further substantiated by a Greek folk-tale and by several of its Slavic variants. In this popular legend, which I will discuss later, a Gipsy nail-smith figures at the Crucifixion of Christ.

Naturally, the questions arise: How did it happen that a Gipsy nail-smith could have ever become connected with this most sacred event which, moreover, was attested, in all its phases, by all four canonical gospels? And how may we account for the fact that the clerical author of the *Cyprus Passion Cycle* introduced this questionable character into his play as a perfect matter of fact; into that play which otherwise so strictly follows the Orthodox tradition? Indeed, not only once but twice does this character appear; for the smith who takes the Lord's body off the Cross, is doubtless meant to be the same fellow.

Medieval Greek literature offered not the faintest clue toward the solution of the mystery; the one Greek folk-legend with its Slavic variants helped to deepen rather than solve it. At the point of giving up, it occurred to me that iconography might provide a hint. In quest of this Gipsy Smith, I turned to Byzantine pictures of both the Crucifixion and the Deposition. The former yielded nothing; but all those of the Deposition showed a man in a short tunic who, with a pair of large pincers, extracted the nails that pierced the Lord's hands and feet.

All these pictures of the Deposition can be traced back to a pre-Byzantine prototype best represented by the miniatures of the so-called Rossano manuscript of the Greek gospels (6). The Byzantine type based on it represents the canonical tradition of the Orthodox Church, for it is this type that is described in the *Byzantine Guide to Painting*, a well-known compendium of rules for ecclesiastical artists (7).

With this in view, it was all the more perplexing to discover that the situation shown in this compositional pattern of the Deposition (Fig. 1) in no way illustrates any of the four canonical gospel accounts of this event, but that it depicts the incident such as told with much elaborate detail in an early medieval Greek legendary Life of Christ which, in turn, is based on the fanciful account of the apocryphal *Gospel of Nicodemus* (8). According to these non-canonical records, it was Nicodemus who, together with Joseph of Arimathaea, took down the Lord's body from the Cross; and it is minutely described, how they climbed up two ladders to the arms of the Cross, and how Nicodemus pulled out the big iron nails.

In a very few of the numerous cases where this elaborate and unbiblical pattern of composition was used in mural frescoes, we find the name of "Nicodemus" inscribed near the nail-extracting figure; the *Byzantine Guide to Painting* also expressly states that it is Nicodemus who extracts the nails. The manner, however, in which the nail-extracting man is generally represented in the pictures of that pattern, was more likely to obscure, than to stress, his identity as Nicodemus: in the vast majority of pictures, he wears a short tunic and has bare legs and feet, while all the other sacred personages in the picture wear long tunics draped with cloaks; this applies equally to murals and to miniatures of gospel books. In the miniatures, moreover, the name of "Nicodemus" is never found ascribed, and it occurs in only a very few of the murals. Not a single miniature is known in which the nail-extracting man possesses a halo, while there is only the one or the other mural in which he is nimbed. In the majority of pictures this man is also much smaller of stature than the other sacred persons. How then could the people be expected to know that this swarthy little fellow was intended to be Nicodemus and not just what he looked like: a lowly *komodromos*, a Gipsy nail-smith, the kind that were roaming about the country-side making and peddling nails and metal-ware?

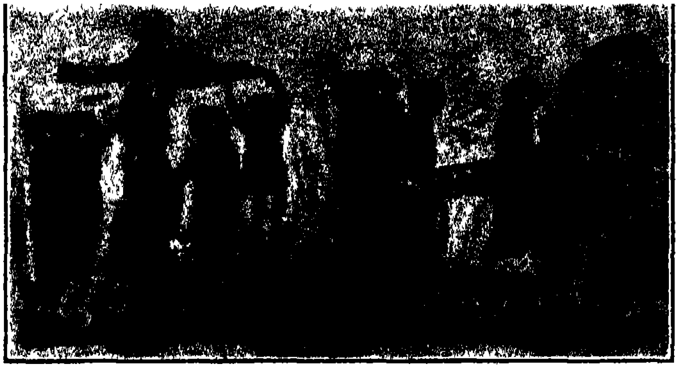


Fig. 1

Miniature from Byzantine Gospel Manuscript, 11th Century (*Paris, Bibl. Nationale, gr. 74*, fol. 208v). From H. A. Omont, *Evangiles avec Miniatures Byzantines de l'XIe Siècle* (Paris, 1908), p. 181.

Whenever in church any of the four gospel accounts of the Deposition was recited, was there ever a word said about Nicodemus' taking the Lord off the Cross, let alone, extracting the nails with pincers? Not even the clerics, when reading these accounts in their gospel books, could be expected to identify as Nicodemus the little nail-extracting figure of the miniature which, most inconsistently, accompanied each of the gospel accounts (9) but in no way fitted any of the four versions. Besides, there is another factor contributing to the belief that this figure was nothing but a common Gipsy smith: very frequently, the miniatures of this compositional pattern show, on their right side, Joseph and Nicodemus carrying the body of Christ to the grave (Fig. 1); in this half of the pictures, both figures invariably are equally tall, both have haloes and wear the long tunic with the himation; and since this part of the illustration actually fits the gospel account in which both Nicodemus and Joseph are mentioned by name (10), there could be no doubt in Nicodemus' identity, while the little nail-extracting fellow, over on the left, was all the more certain to be taken for just a common Gipsy nail-smith.

For the anthropologist, it is of especial interest to observe that the very existence of this notion presupposes a thorough familiarity on the part of the people with the Gipsies as the makers of nails and other ironware. It was so much a matter of course to buy whatever nails were needed from the vagabond Gipsy smiths, that the people could not see how this ever could have been different; and since they had no feeling for anachronisms either, they naturally believed that the nails for the Crucifixion of Christ could not have come from anyone but a Gipsy. Weren't there in the very gospel book the pictures of the Gipsy pulling the nails, and was it not just as likely that this same Gipsy nail-smith also had hammered them in?

I have mentioned the Greek folk-legend about the Gipsy nail-smith at the Crucifixion of Christ. It was found on the Ægean island of Lesbos and also occurs in a few Slavic variants. As was the case among the Greeks, the basic notion was doubtless spread among the Slavic peoples by the pictures of the Deposition which, in the Slavic gospel books are essentially the same as those in the Greek gospels. They show exactly the same swarthy little nail-extracting fellow in the short tunic and with the bare legs.

Now as to the legend itself, in the Greek story, from Lesbos (11), the Virgin Mary meets the nail-smith, a Gipsy, and asks him whether he had seen her son. He replies that he was going to make five nails, instead of four, toward her son's impending crucifixion. Whereupon she curses him to be homeless forever.

Two variants, almost identical with each other as well as with the Lesbos version, are somewhat more explicit about that fifth nail; one is from Bulgaria (12), the other, from Bessarabia (13). In these stories, the Gipsy says that he has induced the Jews to drive the fifth nail into Christ's side [*Bulgaria:* . . . into Christ's heart]. Accordingly, the punishment is more clearly defined than in the Lesbos version: the Virgin curses the Gipsy to be black, enslaved, to be a smith, and to be despised by all [*Bulgaria:* . . . never to get anything to eat unless he begs for alms].

The Little Russians of Galicia have the following version (14): When Christ was crucified, the Gipsy nail-smith brought four nails and said that all of them were likely to be useful. However, only three were used; but Christ cursed the Gipsy that he should stray as useless as that fourth nail.

Another legend of Little Russia, from Galicia (15), tells this story: The Jews themselves dared not nail Christ to the Cross but commissioned a Gipsy to hammer in five nails. The Gipsy, however, drove in only four and swore that this was the number he had been hired for. Thenceforth, the Gipsies have been privileged by God to swear false at the fairs.

All these stories clearly express the people's contempt for the Gipsies. However, there is another set of versions that are favorable to the Gipsy in that they modify the basic motif: far from providing the nails for the Crucifixion, let alone, making them more than necessary, the Gipsy, now, steals one nail and, instead of being cursed, is being blessed, by Christ.

As the Gipsies strayed farther and farther away from the Greek domain into the Slavic Balkan countries and beyond, they appear to have learned how to take the sting out of this legend so persistently harmful to their reputation, by twisting it in their favor and peddling it themselves. A feeble attempt in this direction may perhaps be seen in the last-told of the two Little Russian variants, the tone of which is decidedly conciliatory.

I do not doubt, for instance, that the Gipsies had a hand in spreading among the Little Russians of Galicia, a story (16) in which the Carpenter (*not being* a Gipsy) is cursed never to become rich because he has made Christ's Cross, but the blacksmith (*being* a Gipsy) is blessed because he stole one of the nails.

Obvious pro-Gipsy propaganda may be seen in the following story from Lusatia (17), an East-German region inhabited by Slavic Wends: The Gipsy is blessed by Christ because he steals one of the four nails, so that Christ may be crucified with only three, thus sparing Him the disgrace of hanging on the Cross with His legs parted.

I want to conclude with two stories that were collected in a Gipsy camp in Alsace (18); sure proof that this type of the legend is actually peddled by the Gipsies themselves. Here is one of them: When Christ was about to be crucified, a Gipsy woman who was walking past, stole one of the four nails, so that Christ was crucified with only three. Therefore, the Gipsies are privileged to steal once in seven years.

This is the other story: When Jesus was about to be crucified, there were in the crowd two Jewish brothers, called Schmul and Rom-Schmul. Schmul showed a cruel satisfaction at the impending suffering of the Lord, but Rom-Schmul would have loved to save Christ from His terrible doom. That being, of course, impossible, he at least wished to show his good will; so he stole one of the four nails, and Jesus was crucified with only three. Later Rom-Schmul became a Christian, while his brother remained a Jew. It is this Rom-Schmul who became the ancestor of the Roms, as the Gipsies call themselves in their own language.

NOTES AND LITERATURE

(1) **Vogt, A.** *'Études sur le Théâtre Byzantin'*, in *Byzantion*, VI (1931), p. 49–63.
I have recently completed a reconstruction from this scenario of the entire *Cyprus Passion Cycle* in the original Greek. It is ready for the printer, together with an English translation, notes, and a detailed discussion of its literary character and history.

(2) **DuCange, C. Dufrense, Sieur.** *Glossarium ad Scriptores Mediae et Infimae Graecitatis* (Bratislava, 1891; re-impression of the edition of 1699).

(3) **Vogt, A.** *op. cit.*, p. 72, note 2.

(4) **Miklosich, F. von.** *Ueber die Mundarten und die Wanderungen der Zigeuner Europas*, in *Denkschriften der kaiserlichen Akademie der Wissenschaften, Philosophisch-Historische Klasse* (Wien, 1872–1880). See also Hopf, K., *Die Einwanderung der Zigeuner in Europa* (Gotha, 1870).

(5) **Pott, A. F.** *Die Zigeuner in Europa und Asien*, 2 Vols. (Halle, 1844).

(6) **Smith, E. B.** *Early Christian Iconography*, etc. (Princeton University Press, 1918), p. 183.

(7) There exist numerous manuscript versions of this work which has been in use—basically unchanged but modified in detail—in the painters' workshops of the Greek Orthodox Church throughout the greater part of the Christian era One of them is printed, in translation, in Didron, A. N., *Christian Iconography*, etc. (English edition by J. Millington and M. Stokes), 2 Vols. (London, 1907), II, pp. 312–321.

(8) See **Donehoo, J. D.**, *The Apocryphal and Legendary Life of Christ*, etc. (New York, 1903), p. 366. For the apocryphal Gospel of Nicodemus, see *Evangelia Apocrypha*, ed. C. Tischendorf, 2nd edition (*Leipsig*, 1876).

(9) *Mark* XV: 46–47; *Matt.* XXVII: 59–61; *Luke* XXIII: 53; *John* XIX: 38–42.

(10) *John* XIX: 39–40.

(11) See **Dähnhardt, O.**, *Natursagen*, 2 Vols. (Leipzig, 1907), II, p. 294, from Georgeakis & Pineau, *Folklore de Lesbos*, p. 273.

(12) *ibid.*; II, p. 216. See also Rappoport, A. S., *Medieval Legends of Christ* (London, 1934), p. 232.

(13) *ibid.*; II, p. 217; from *Jubilejyni Sbornik v cest Millera*, etc. (ed. W. A. Jancuka), p. 95.

(14) *ibid.*; II, p. 216 f.; from Hnatjuk, *Galicko-ruski narodni legendi* (= *Etnograficnij Zbirnyk*, XII and XIII).

(15) *ibid.*; II, p. 217; see also Polivka, *Archiv fur slavische Philologie*, XIX, p. 263.

(16) *ibid.*; from Hnatjuk, *op. cit.*

(17) *ibid.*; from Schulenberg, W. von, *Wendische Volkssagen and Gebrauche* (Leipzig, 1880), p. 47 f.

(18) *ibid.*; II, p. 293 f.; see also *Gipsy Lore Journal*, I (1889), p. 253.

THE ANTS OF ASHTABULA COUNTY, OHIO (HYMENOPTERA, FORMICIDAE)

A. E. HEADLEY[1]
1705 East 46th Street, Ashtabula, Ohio

This list of ants collected in Ashtabula county and vicinity was compiled with two purposes in mind. First, to give some aid in determining the number of species of ants found in Ohio. Second, to record any interesting observations on ant behavior and ecological factors determining their distribution.

Collections were made for the most part during the spring, summer and late fall of 1938. A few collections were made during the fall months of 1937 and the spring of 1939. A record of each nest was made as to its location, habitat, general structure and environment, the date taken and interesting occurrences in the nest. The types of ants collected; whether they were workers, winged forms, queens, pupae, etc., were noted. The ants collected were placed in one dram vials with seventy per cent alcohol acting as a preservative.

DESCRIPTION OF THE REGION

The collecting area has been separated into three regions that seem to be distinct as to soil features and general topography. First, a lake plain strip about five miles in width south of the present shore of Lake Erie. Two parallel sand ridges mark the ancient beach lines at former lake levels—North Ridge and South Ridge. The soil of this region is mostly sand, with some gravel and sandy loam. Second, the gulf and ravines of the Grand River along the western side of the county; also a small part of Geauga county bordering Ashtabula on the west. This second region is all well drained and has a clay soil. The third area is south of the lake plain region, where the land is poorly drained and the topography is flat, rolling ground. This section has an impervious shale base with heavy clays from the glacial drift. (Read, '73).

The forests in these areas differ. In the lake plain region the forests east of Ashtabula city contain considerable hemlock with Beech-Sugar Maple-Tulip subtype occurring. (Hicks, '34). Toward the western side of the lake plain section are found Beech-Maple forests with scatterings of white elm, oaks, common locusts and hemlock.

The better drained section along the ravines of the Grand River is an Oak-Hickory association with scatterings of sugar maple, beech, white ash, tulip, hop hornbeam, wild cherry, and trembling aspen. Hemlock is found along the sides and bottoms of the ravines. The forests of the Geauga area are Oak-Hickory with sugar maple, beech, white ash, and white elm.

In the poorly drained section south of the lake plain region are found sugar maple, beech, white elm, walnut, tulip swamp white oak, some linden and trembling aspen.

ECOLOGICAL FACTORS

Dr. Shelford states: "Since the environment is a complex of many factors, every animal, while in its normal environmental complex, lives surrounded by and responds to a complex of factors in its normal activity." (Shelford, '13). Thus it is impossible to study any group of organisms without taking into consideration their environmental surroundings.

---

[1] The author wishes to express his indebtness to Dr. C. H. Kennedy for all his help and advice in this work. Also for the use of his library which made reference study possible. The necessary laboratory work was done at the Franz Theodore Stone Laboratory, Gibralter Island, Put-in-Bay, Ohio. Myrmicas were identified by N. A. Weber.

Certain species of ants establish their nests where the sun can shine directly on them. Such species as *F. pallide-fulva* varieties, *F. fusca* var. *subsericea*, *F. sanguinea* varieties, *Lasius niger* var. *neoniger*, *F. exsectoides* and *Crematogaster lineolata* are found in fields and the borders of woods or open sunny places in woods.

Other ants are constantly associated with woods. In this region there can be distinguished no ants limited to a particular type of forest, the same species being found in oak-hickory or beech-maple climax woods. There are fewer ants not only in numbers but also species in a predominately hemlock area due possible to the covering of the ground with hemlock needles.

For log inhabiting ants the amount of deterioration of the logs determines what species are established in them. *Ponora coarctata pennsylvanica*, *Proceratium silaceum*, *Stigmatomma pallipes*, *Lasius claviger*, *Lasius umbratus*, *mixtus* var. *aphidicola*, and *Camponotus herculeanus ferrugineus* are found in logs rotted inside to a substance that can be dug out with the hand. This material is damp and fine enough so that the actual nest and galleries are often destroyed before the ants are seen. It is noted that ants do not occur in beech logs with stringy fibers. Wood inhabiting ants are seldom if ever found in logs that are moldy throughout.

The following species: *Camponotus herculeanus pennsylvanicus*, *Aphaenogaster tennesseensis* and *Creamtogaster lineolata* require solid logs or tree trunks with less moisture.

Small ants such as the *Leptothorax* genus are found in the cracks and crevices of the bark of solid logs *Leptothorax acervorum* subs. *canadensis* spread their nests over two or three feet of solid maple bark located in sunny openings of the woods. The species *Leptothorax fortinodis* also nest in fallen maple trees with firm bark found in sunny places in woods; but restrict their nests to small areas two or three inches in diameter.

The mound building ants, *F. exsectoides*, nest principally in clay soils. These ants were plentiful south of the lake plain in clay, but only three nests were collected in sandy regions. These nests in the sandy areas were low flat mounds, while in the clay soils the nests grew quite large and cone shaped. The *F. fusca* var. *subsericea* mounds were plentiful in clay, being larger and more substantial than those of sandy regions.

Slave making species of the *F. sanguinea* group can live only in the vicinity of their slaves, which in this region are *F. fusca* var. *subsericea*. Similarly *Harpagoxenus americanus* is found only where *Leptothorax longispinosus* or *curvispinosus* are abundant.

The great adaptability of ants to food conditions makes it difficult to say that certain types of ground flora are required.

Geographically speaking the area seems to be too far east for *Formica ulkei* and it has not been collected. Just what the limiting factors are can not be stated. *Leptothorax acervorum* supsp. *canadensis*, a northern ant, seems to reach its southern limit in this region having been collected along the lake plain area.

FAMILY FORMICIDAE

Subfamily PONERINAE

Genus **Stigmatomma** Roger

Stigmatomma pallipes (Haldeman).

Typhlopone pallipes Haldeman. 1844. Proc. Acad. Nat. Sc. Phila. 2: 54. Worker.

Three workers were collected. Two were found under rocks in damp clay soil located in Beech-Maple woods. The rocks extended from three to five inches under the surface of the ground where it was always dark and damp. A third worker was found in a wet maple log whose rotted material could be combed through the fingers. This ant is a rare and primitive species which is subterranean in its habits.[3]

Genus **Proceratium** Roger

Proceratium silaceum Roger.

Proceratium silaceum, Roger. 1863. Die neu aufgeführten Gattungen und Arten meines Formiciden-Verzeichnisses. Berl. Ent. Zeitschr. 7: 131–172. Worker.

This primitive ant is as rare as the preceding species, one worker only having been taken. The specimen was found wandering along a large white oak log that had rotted inside to a very damp punk. The log lay in a moist Beech-Maple woods. Locality, Thompson, (Geauga Co.).

Genus **Ponera** Latreille

Ponera coarctata Latr. subsp. **pennsylvanica** Buckley.

Ponera pennsylvanica Buckley. 1866. Descriptions of new species of North American Formicidae. Proc. Ent. Soc. Philad. 6: 171. Worker.

A much more abundant species than the two previously described. Nests were found in rotting stumps or logs, under stones, and in acorns lying in moist places. Workers, larvae, pupae, winged forms and nest queens have been taken. Males and females were collected from the fifteenth of August to the eighth of October.

All the nests were small, some with irregular and apparently unfinished galleries. This ant moves slowly and does not rush out in the face of danger to retrieve the brood as would one of the *F. pallide-fulva* group. (Wheeler, '10, Ants, p. 238).

Subfamily MYRMICINAE

Genus **Myrmecina** Curtis

Myrmecina graminicola subsp. **americana** Emery.

Myrmecina latreillei subsp. *americana* Emery. 1895. Beiträge zur Kenntniss der nordamerikanischen Ameisen fauna. Zool. Jahrb. Syst. 8: 271. Worker.

One nest of this rare ant was collected from an acorn in a dense camp Beech-Maple climax forest. The ground had no vegetation other than moss. From this nest workers, pupae, one male and nest queen were taken.

Genus **Monomorium** Mayr

Monomorium Pharaonis (Linne).

Formica pharaonis Linne. 1758. Syst. Nat. Ed. 10: 580.

This tiny yellow ant has been transported all over the world by means of ships. Workers were taken from an apartment house in Cleveland, Ohio. They were found from basement to top floor raiding kitchens and bath rooms. Two lines would be formed, ingoing and outgoing, traveling in single file. They would be found in the butter, meats (bacon particularly), soaps, cold creams, etc.

It was wrongly thought by Linnaeus that the Egyptians were plagued by ants as well as other insects during Biblical times. Thus he gave them the name "Pharoah's Ants." They are believed to have originated in India.

Genus **Solenopsis** Westwood

Solenopsis molesta (Say).

Myrmica molesta Say. 1836. Descriptions of new species of North American Hymenoptera and observations on some already described. Bost. Journ. Nat. Hist. 1: 293. Worker.

Nests are found in open grassy places, under logs, stones or bark of trees. The species frequently nests with other ants such as the *Formica fusca* group, the *F. pallide-fulva* group, *Tapinoma sessile*, *F. exsectoides*, *Myrmicas* or *Aphaenogasters* that are in mounds or in the ground.

---

[3] Unless otherwise stated each ant mentioned in this paper has been collected in Ashtabula County.

Living up to its name, the thief ant, it can be very annoying in the kitchen at times. Males and females were found from the fifteenth of July through August.

Genus **Crematogaster** Lund

Crematogaster lineolata (Say).

Myrmica lineolata Say. 1836. Descriptions of new species of North American Hymenoptera and observations on some already described. Bost. Journ. Nat. Hist. 1: 290. Worker, female, male.

The colonies are found in fields and open woods nesting in rotting but fairly solid stumps, or logs, under bark and stones or in old abandoned *F. fusca subsericea* mounds. There is a wide range and much variation in types of localities of nests. Some are in damp places, but most are in fairly dry habitats. If one jars a stump these ants will boil up out of cracks and crevices. In general the colonies are large. Males and females are present from early August to late September.

Crematogaster lineolata var. **cerasi** (Fitch).

Myrmica cerasi, Fitch. 1854. Trans. N. York State Agric. Soc. 14: 835. Worker.

This variety has the same general form as the previously described *Crematogaster*, but is lighter in color, the thorax having more red on it. It is difficult to distinguish between the varieties. Nest locations have the same environment as *Crematogaster lineolata*.

Genus **Aphaenogaster** Mayr

Aphaenogaster fulva Roger.

Aphaenogaster fulva Roger. 1863. Die neu aufgefuhrten Gattungen und Arten meines Formiciden-Verzeichnisses. Berl. Ent. Zeitschr. 7: 190. Worker.

Nests are in damp woods, under stones, in rotting wood, often under clumps of leaves in a careless fashion. The soil is generally a clay with some sand. Males and females were found from the fifteenth of July to the twenty-fifth of September.

Aphaenogaster fulva Roger subsp. **aquia** (Buckley).

Myrmica (Monomorium) *aquia* Buckley. 1867. Descriptions of new species of North American Formicidae. Proc. Ent. Soc. Philad. 6: 341. Worker, female.

This reddish brown ant differs in habitat from *Aphaenogaster fulva* in being found in more open places; in fields, by roadsides and openings in woods. Nests are found under stones, in logs, under grass and dead vegetation. The soil may be clay or sandy loam.

Aphaenogaster fulva subsp. **aquia** var. **picea** (Emery).

Stenamma (A.) *fulvum* subsp. *aquia* var. *piceum* Emery. 1895. Beitrage sur der Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 8: 305. Worker, female, male.

This ant has the same general outlines of the subspecies *aquia* but has a pitchy black color. It may be confused sometimes with *Aphaenogaster fulva*. The nesting sites are the same as those of the species *fulva*.

Aphaenogaster tennesseensis (Mayr.).

Atta tennesseensis Mayr. 1862. Verh. Zool.-bot. Ges Wien. 12:743. Worker.

An ant with a cherry red color when seen in the field. It has epinotal spines longer than any other local *Aphaenogaster*. The typical nesting sites of this ant are found to be off the ground high up in stumps or in the top portion of logs or dead limbs, that do not touch the ground. The nests are located in places where sunshine can get to them. Winged forms were taken July 30, 1939. Nesting habits indicate that *tennesseensis* is aboreal rather than terrestrial.

Genus **Myrmica** Latreille

Myrmica punctiventris Roger.

Myrmica punctiventris Roger. 1863. Berl Ent. Zeitschr. 7: 190. Worker.

The nests for the most part were located in moist shady woods, with moss growing on the ground and sides of trees. Several nests were collected from acorns that were damp inside and had considerable amounts of debris in them.

Myrmica scabrinodis subsp. **lobicornis** var. **fracticornis** Emery.

Myrmica lovicornis Nyl. subsp. *fracticornis* Emery. 1894. Zool. Jahrb. Syst. 8: 313.

A nest of this variety was collected in an open sunny spot of a Beech-Maple woods. The soil was fairly dry, sandy, loam. Vegetation was grass, club moss, cinquefoil, green ash, hazel nut, bushes, maple and white oak trees. There was no mound, just an opening from which a gallery extended down eight inches.

Myrmica scabrinodis subsp. **schencki** var. **emeryana** Forel.

Myrmica schencki Emery subsp. *emeryana* Forel. 1914. Deutsche Ent. Zeitschr. P. 617.

Four nests of this ant were collected in widely separated areas of the county. They were found in open fields or in sunny spots at the edges of woods. The soil consisted of clay or shale, generally dry and hard. Vegetation was predominantly grass, cinquefoil and berry vines. Surface structure of the nests varied. In some, openings were scattered over small domes of earth, in others they were flat at the surface, or under logs and stones.

Myrmica sabuleti subsp. **americana** Weber.

Myrmica sabuleti Meinert subsp. *americana* Weber. 1939. Lloydia 2: 144–6.

Nests were found in open fields where the soil was dry clay and the vegetation was grass, cinquefoil and berry vines. One nest was found in sand. Openings could be traced down for about a foot below the surface.

Genus **Leptothorax** Mayr

Leptothorax acervorum subsp. **canadensis** Provancher.

Leptothorax canadensis Provancher. 1887. Addit. Faun. Canada Hym, p. 245. Worker, female, male.

One nest was collected north of Geneva, Ohio. It was under the bark of the trunk and part of a branch of a fallen sugar-maple tree located in an open glade in a Beech-Maple woods. When the bark was lifted off the ants were captured as they came to the surface from their galleries that ran lengthwise of the soild wood. Workers only were collected from this nest. The ant is a northern form as the name indicated. The nest collected is the only record so far for Ohio.

Leptothorax fortinodis Mayr.

Leptothorax fortinodis Mayr. 1886. Die Formiciden der Vereinigten Staaten von Nordamerika. Verh. Zool.-bot. Ges. Wien. 36: 451–452. Worker, female.

A single colony of this species was taken. It was found in the bark of a fallen maple tree located in an open sunny area of a dense Beech-Maple woods. The nest was small, not more than three inches in length. It is the exact opposite of the previous form which spreads out over a large area of a log. The collection was made July 28. Workers, pupae, nest queen and two males were taken.

Leptothorax longispinosus Roger.

Leptothorax longispinosus Roger. 1863. Die neu aufgeführten Gattungen und Arten meines Formiciden Verzeichnisses. Berl. Ent. Zeitschr. 7: 180. Worker.

The nests of this small dark ant are found under the bark of dead and living trees, in acorns, snail shells, in hollow twigs and oak galls. Quite often one or two may be seen by a collector without his being able to locate the nest.

Twenty-four acorn nests were collected in an area twenty by twenty-five feet, located along the top of a ravine cut by the Grand River. The acorns were one-half inch in diameter, having fallen from red oak trees. The outside covering of each was solid except for a tiny opening next to the ground. The acorn centers were hollow and dry, some being exceedingly clean while others contained a small amount of debris. Since collections were from mid-September to the middle of October practically all of the nest inhabitants were procured. It would seem that a semi-hibernating condition existed. The largest nest contained one hundred and ten workers and a nest queen. The average sized nests contained forty to fifty workers together with the nest queen and pupae. The smallest nests contained four to seven workers; however, they contained *Harpagoxenus* queens which would indicate that a number of workers had been killed in a raid.

The choice of acorns for nests is correlated with the fact that colonies are generally small. Small colonies are due possibly to the relatively small fecundity of the female since she is but little larger than the worker. Then, too, there is usually not more than one fertile female to a nest according to the records of this region. Only one nest contained two normal queens together with one aberrant female.

Leptothorax curvispinosus Mayr.

Leptothorax curvispinosus Mayr. 1866. Myrmecolgische Beiträge. Sitz.-ber. Akad. Wiss. Wien. 53: 508, pl. f. 13. Worker.

This ant nests in hollow twigs, under bark of trees in acorns and oak galls. An occasional ant will be seen wandering about in the grass or on the twigs of bushes, To find the nest of such wanderers infinite patience is required.

Complete nests were taken from acorns lying on the ground. These acorn nests always had a good outside covering however thin they might be. The inside would be dry with small amounts of debris. The woods were open Beech-Maple with a scattering of red and white oak trees. The soil was dry clay with a shale base. The ground vegetation was mostly grape vine runners and some tufts of grass. Workers, nest queen, larvae, and pupae were collected.

Leptothorax curvispinosus subsp. **ambiguus** Emery.

Leptothorax curvispinosus subsp. *ambiguus* Emery. 1894. Beiträge zur Kenntniss der Nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 8: 317–320. Worker.

Ten nests were collected; four from soil at the edges of woods in open fields; six from acorns of red oaks scattered along the edges of Beech-Maple woods.

The ants from nests collected in open fields were light in color. The colonies were located in and among roots of cinquefoil (*Potentilla palustris*) and sheep sorrel (*Rumex acetosella*). The nest would spread out a foot in radius with galleries running underground from one group of roots to another; or around the roots of one plant. By carefully pulling up the cinquefoil the nests were encountered one or two inches under the surface of the ground. The soil was always dry, fairly hard clay. Nest locations were far enough out from tree trunks to get plenty of sunshine. The principal vegetation was cinquefoil, sheep sorrel, golden rod and plantain with oak trees along edge of woods. Workers, pupae and nest queens were collected.

Ants collected from acorns were of a darker hue. The acorns were one-half inch in diameter and were from red oak trees. The outside shell was in perfect condition with a small opening on the surface next to the ground. They were dry inside with little debris. There was some ground flora, grape vine runners and tufts of grass. These nests were located at the top of a ravine of the Grand River, at Harpersfield, Ohio.

Genus **Harpagoxenus** Forel

Harpagoxenus americanus (Emery).

Tomognathus americanus, Emery. 1895. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 8: 272. Worker.

A black ant recognized by the groove formed by the frontal carinae which extend back to the vertex, giving the antennal scapes a resting place.

This extremely rare ant enslaves species of *Leptothorax*. Three isolated queens were taken from small *L. longispinosus* in nests found in acorns. Another interesting nest was made up of both *L. longispinosus* and *L. curvispinosus* workers together with two *H. americanus* workers without a queen. An explanation of this unusual nest might be found in Dr. Creighton's article entitled "The slave raids of Harpagoxenus americanus." He explains an almost similar mixed colony found by Wheeler in this manner. "I would consider Dr. Wheeler's mixed *Leptothorax* colony as a remnant originally formed by dulosis from which the *Harpagoxenus* had migrated or been killed off while raiding."

About 50 acorn nests of various species of *Leptothorax* were collected along the top of a ravine of the Grand River at Harpersfield in an attempt to locate more, and complete, *Harpagoxenus americanus* nests; they are yet to be found.

Subfamily DOLICHODERINAE

Genus **Tapinoma** Förster

Tapinoma sessile (Say).

Formica sessilis Say. 1836. Descriptions of new species of North American Hymenoptera and observations on some already described. Bost. Journ. Nat. Hist. 1: 287–288. Worker, female.

A very common ant nesting under rocks, logs in old mounds of other ants, under bark of trees and clumps of dead leaves. The nests are in fields or open woods, where the sun can get to them. They often have an untidy appearance as if housekeeping had just started, nothing being in place. Pupae are often piled up in heaps or just under the bark of a log in a careless manner.

Subfamily CAMPONOTINAE

Genus **Prenolepis** Mayr

Brachymyrmex heeri subsp. **depilis** Emery.

Brachymyrmex heeri Forel subsp. *depilis* Emery. 1895. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 635. Worker, female, male.

Nests are located under stones of open woods. The soil may be rather dry clay. Colonies are always small and do not go more than one or two inches down into the ground under the stones. Males and females make their appearance from the middle of August to late September.

Prenolepis imparis (Say).

Formica imparis Say. 1836. Descriptions of new species of North American hymenoptera, and observations on some already described Bost. Journ. Nat. Hist. 1: 287. Female, male.

This interesting ant is found most readily in gardens, under grape arbors and fruit trees in sandy soil. They are the first ants to open their crater nests in the spring. At that time there will be a flight of males and females which have wintered over. During the hot summer months workers are not readily found but in the fall they open the nests again and are numerous on fallen fruit.

Prenolepis imparis imbibes fruit juices and secretions of flowers, loading their gasters until they are so distended that walking is difficult. Many workers winter over in this replete condition. In this respect they resemble the honey ants (*Myrmecocystus*) of southwestern United States and Mexico.

Genus **Camponotus** Mayr

Camponotus herculeanus subsp. **pennsylvanicus** (DeGeer).

Formica pennsylvanica DeGeer. 1773. Mem. Serv. Hist. Insect. 3: 603. Pl. 31, figs. 9, 10. Worker, female, male.

A large black ant commonly called the "carpenter ant." The nests are in dead logs, stumps or decayed centers of living trees, or in the wooden foundations of houses. Galleries are formed all through their abode.

When a nest is opened in which a young queen and her brood are found the queen will stand over the brood attempting to guard it. This would indicate to a high degree the instinct of protection. It is certainly the opposite of the case found in the *Ponerinae* subfamily where workers move away from the brood when disturbed.

This ant will make trails an inch in width from one tree to another The workers have been observed to lie down on their side and take a "nap" while traveling these trails. When disturbed these ants will run along a slab or bark and drop over as if dead, completely relaxed; when the danger is passed they will scurry along to a safe hiding place.

When a nest has been built in the timbers of a house much damage may be done before the occupants are aware of the fact.

Camponotus herculeanus subsp. **pennsylvanicus** var. **ferrugineus** Fabr.

Formica Ferruginea (Fabricus J. Chr.). 1798. Suppl. Ent. Syst. p. 279. Worker, female.

The only nest taken was found in a very damp maple log; the rotting material so fine it could be sifted through the fingers. This log lay in a Beech-Maple woods that was quite damp. Only the queen and her first brood were collected.

Camponotus herculeanus subsp. **ligniperdus** var. **noveboracensis** (Fitch).

Formica noveboracensis Fitch. 1854. N. York State Agric. Soc. 14:52. Worker.

This ant is not as abundant as *C. herculeanus pennsylvanicus* but has the same nesting habits as the other. Workers, pupae, winged males and females were collected. The winged forms were taken July 30.

Camponotus caryae (Fitch).

Formica caryae Fitch. 1855. Trans. N. York State Agric. Soc. 14: 855–859. Worker, female, male.

A black ant separated from the larger *Camponotus* group by a notch in the middle of the anterior border of the clypeus.

This is not an abundant species and only a few workers have been collected as they wandered about on the stems of blackberry canes and beech shoots in open fields.

Genus **Lasius** Fabricius

Lasius niger var. **neoniger** Emery.

Lasius niger var. *neoniger* Emery. 1893. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 639. Worker, female, male.

This ant and *Lasius niger americanus* are the only *Lasius* varieties that are not strictly hypogaeic. Workers are seen above ground in the foliage of trees attending aphids. *Lasius niger* var. *neoniger* has a preference for sandy soil in which habitat it replaces *L. niger* var. *americanus* in abundance. Occasionally it will nest in a log or stump but for the most part it is found in small crater shaped nests in sandy soil.

Lasius niger subsp. **alienus** var. **americanus** Emery.

Lasius niger alienus var. *americana* Emery. 1893. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 639. Worker, female, male.

This is the most common ant in the region. Colonies are found nesting under stones, bark, in logs and stumps; they may be in ground that is damp or dry, in fields or woods, thus, showing great adaptability to the physical conditions which they encounter.

This ant is a pest in gardens and fields where it will place aphids on rose bushes, the roots of corn, etc. Winged forms were collected from late July to the middle of September.

Lasius flavus subsp. **nearcticus** Wheeler.

Lasius flavus var. *nearcticus* Wheeler. 1906. New ants from New England. Psyche. 13: 38–39.

One nest was collected and it did not conform to the usual nesting situation of other localities. Usually this ant is found in damp places under stones or leaf mold in well shaded woods. The nest collected was found under a flat stone eight by ten inches. The ground was hard, dry clay in an open Beech-Maple woods. There was no ground vegetation and the only trees were sugar-maples and white oaks. Workers and pupae were collected.

Lasius umbratus subsp. **mixtus** var. **aphidicola** (Walsh).

Formica aphidicola Walsh. 1862. On the genera of aphidae found in the United States. Proc. Ent. Soc. Philad. 1:310. Worker, male.

This ant is found nesting in the damp rotten wood of stumps or under rocks located in moist places. They most generally inhabit deep Beech-Maple woods; however, they will nest in a field if the moisture is sufficient. They are hypogaeic, attending white root aphids. Workers and one nest queen were collected.

Lasius (Acanthomyops) claviger Roger.

Formica clavigera Roger. 1862. Einige neue exotische Ameisen-Gattungen und Arten. Berl. Ent. Zeitschr. 6: 241–242; 1, fig. 13. Female.

Two nests of this species were collected, both nests being in stumps of trees that had rotted to a condition almost beyond recognition. This rotted punk was damp enough to be molded in the hands. The main portion of the nests was found in the center of stumps with Virginia creeper growing up through it. On the roots of this plant the ants had placed white aphids. A lemon verbena odor is given off by these ants.

Genus **Formica** Latreille

Formica sanguinea subsp. **subintegra** Emery.

Formica sanguinea subsp. *rubicunda* Emery var. *subintegra* Emery. 1893. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 648, pl. 22, fig. 3. Worker, female.

This ant enslaved *F. fusca* var. *subsericae* by making forays to capture the young, thus making mixed colonies of the two species. The soil is generally clay with sand mixed in with it. Workers only were collected.

Formica sanguinea subsp. **subnuda** Emery.

Formica sanguinae subsp. *rubicunda* Emery var. *subnuda* Emery. 1895. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 8: 335. Worker.

The nests are located at the edge of woods in sunny places. There may be a "bed" of openings a foot or more in diameter, level with the ground. The soil is generally sandy clay. Grass is allowed to grow over the mounds. The nests are generally mixed with *F. fusca subsericea* which the sanguinea's raid and enslave.

Formica exsectoides Forel.

Formica exsectoides Forel. 1886. Espices nouvelles de Fourmis Americaines. Ann. Soc. Ent. Belg. 30 C. R. 38. Worker, female.

These mound builders have nests that may be three feet across and thirty to forty inches high. Some mounds in a more sandy soil are only nine inches to a foot in height but are much longer than the higher mounds. Openings into the nests are located along the side walls. The tops of the mounds are covered with debris of small sticks and vegetable matter. Grass grows on the mounds except at the summits. Mounds are built in sunny openings in woods or out in fields. The ants prefer a clay soil. Only three nests were located in the northern part of the county where the soil is more sandy and loose.

Workers from several colonies have been observed attending green aphids on the leaves of trees. The workers will attack when the mound is disturbed and are known to bite off the heads of other ants.

Formica fusca Linnaeus var. **subsericea** Say.

Formica subsericea Say. 1836. Descriptions of new species of North American hymenoptera, and observations on some already described. Bost. Journ. Nat. Hist. 1: 289. Worker, female.

A very common ant, building mounds in clay soil in open sunny places. It is not uncommon to find fifteen to a hundred mounds in a half acre field. They may grow to be two feet in height and three feet in diameter at the base. The openings into the mounds are mostly along the sides with some on the top. The tops of the mounds are generally flat. Vegetation is very abundant about the mounds. These ants also nest under stones or have any number of openings in a "bed," level with the ground.

The ants not only attend aphids but also eat dead insects. *F. fusca subsericea* is a timid ant, allowing other ants such as *Tapinoma sessile* and *Solenopsis molesta* to nest with it. It is raided by *F. sanguinea* varieties which capture some workers, but take pupae mostly.

Formica neogagates Emery.

Formica fusca subsp. *subpolita* Mayr var. *neogagates* Emery. 1893. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 661. Worker, female, male.

Two workers of this species were found traveling along the ground at a rapid rate of speed. The soil was dry, hard clay in a planted white pine forest. These ants were dodging rapidly from one hiding place to another making them difficult to capture. The trees were far enough apart to allow sun to shine on the ground. Grass and poison ivy were the principle vegetation.

Formica pallide-fulva subsp. **nitidiventris** var. **fuscata** Emery.

Formica pallide-fulva subsp. *fuscata* Emery. 1893. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 656. Worker, female.

One nest of this species was collected. It was found out in a cut hayfield under an eight inch square rock. There was one gallery which went down about a foot and then branched in all directions. The soil was a sandy clay that was very dry. The vegetation was blue grass.

Formica pallide-fulva subsp. **schaufussi** var. **incerta** Emery.

Formica pallide-fulva Latreille subsp. *schaufussi* var. *incerta* Emery. 1893. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 655–656. Worker, female, male.

These ants nest in open fields and at the edge of woods, under stones, or in small craters which are difficult to see. The nest has a single opening from which a shaft goes down about a foot or more, than branches out in all directions to form chambers deep in the ground.

BIBLIOGRAPHY

Creighton, W. S. 1927. The slave raids of *Harpagoxenus americanus*. Psyche, 34: 11–29.

1929. Further notes on the habits of *Harpagoxenus*. Psyche, 36: 48–50.

Emery, C. 1911. Hymenoptera, Fam. Formicidae Subfam. Ponerinae. Genera Insectorum. Fasc. 118: 1–125, 3 plates.

1912. Hymenoptera Fam. Formicidae Subfam. Dolichoderinae. Genera Insectorum. Fasc. 137: 1–50, 1 plate.

1921. Hymenoptera Fam. Formicidae Subfam. Myrmicinae. Genera Insectorum. Fasc. 174: 1–392, 7 plates.

1925. Hymenoptera Fam. Formicidae Subfam. Formicinae. Genera Insectorum. Fasc. 183: 1–302, 4 plates.

Hicks, Lawrence E. 1934. The original forest vegetation and the vascular flora of northeastern Ohio—Ashtabula County. (Abstract of Doctor's thesis) No. 13, pp. 109–116. The Ohio State University Press.

McCook, Henry C. 1909. Ant Communities. Harper and Brothers, publishers.

Read, M. C. 1873. Geology of Ohio. 1: 483–492.

Shelford, V. E. 1913. Animal communities in temperate America. University of Chicago Press.

Smith, Roger C. 1934. A summary of published information about Pharoah's Ant, with observations on the species in Kansas. Trans. Kansas Acad. of Sc., 37: 139–149.

Sturtevant, A. H. 1927. The social parasitism of the ant *Harpagoxenus americanus*. Psyche, 34: 1–9.

Talbot, Mary. 1934. Distribution of ant species in the Chicago region with reference to ecological factors and physiological toleration. Ecology, 15: 416–439.

Wesson, L. G., Jr. 1939. Contributions to the natural history of *Harpagoxenus americanus* (Hymenoptera, Formicidae). Trans. of the Am. Ent. Soc. 65: 97–122.

Wheeler, W. M. 1900. The habits of *Ponera* and *Stigmatomma*. Biol. Bull. 2: 43–69.

1903. A revision of the North American ants of the genus *Leptothorax* Mary. Proc. Acad. Nat. Soc. Phila. 55: 215–260.

1910. A revision of the ants of the genus *Formica*. Bull. Mus. Comp. Zool. 53: 379–565.

1910. Ants, their structure, development and behavior. Columbia Univ. Press.

1910. The North American ants of the genus *Camponotus* Mayr. Annals N. Y. Acad. Sc. 20: 295–354.

1910. The North American forms of *Camponotus fallax* Nylander. Jour. N. Y. Ent. Soc. 18: 295–354.

1913. Formicoidea. Hymenoptera of Connecticut. Connecticut State Geol. and Nat. Hist. Survey Bull. 22: 577–601.

LIFE HISTORY AND HABITS OF THE CICADA KILLER IN OHIO

CHARLES A. DAMBACH and EUGENE GOOD[1]
Soil Conservation Service

The Cicada Killing Wasp (*Sphecius speciosus* Drury[2]) has long been of interest to entomologists and of much popular interest to naturalists wherever it occurs. Riley (18) in 1893 published in "Insect Life" the first account of its life history and habits. Observations of the writers have revealed a number of inaccuracies in this report and omission of essential data. These errors and omissions have been repeated by subsequent writers on the subject, particularly Marlatt (12), and Smith (20). Certain of these inaccuracies have been corrected, (Davis 5), but as yet no complete account of the life history and habits of this insect has appeared. For this reason the writers are here attempting to bring together the essential facts concerning its life history and habits based on published accounts and their own observations.

Beginning with the summer of 1934, and continuing through 1940, we studied the habits of this wasp for a period of a week or more each year during the height of its activity. A large part of the data reported on were collected from a colony of these insects consisting of several hundred burrows on a 4-H Club Camp site in Eden Township, Licking County, Ohio. Many observations have been made, however, at other colonies in southern Ohio counties. In addition to our own observations those of other interested individuals have been reported to us.

DESCRIPTION AND DISTRIBUTION

Due to its large size, general distribution and interesting habits *Sphecius speciosus* has been described in many insect books and needs no further description here. Its habit of digging burrows and provisioning them with cicadas is the means by which it is usually recognized and has earned it the name of cicada killer, sand hornet or golden digger-wasp.

In Ohio, *Sphecius speciosus* is most abundant in the southern two-thirds of the state but records from as far north as Cleveland in Cuyahoga County and Van Wert in Van Wert County have been obtained. Colonies appear to be most numerous in the unglaciated Allegheny Plateau and to occur only locally elsewhere. Although complete records are not available it is quite probable that it occurs in all of the counties, south of the Lake Erie drainage. Twenty-five of the 27 counties for which records are available are in this area.

LIFE HISTORY

Emergence:

At Dayton, Ohio, during a three-year period (1937–1939), the average date for the emergence of adults from Sphecius larval cases stored over winter in well-drained soil was July 1. Specimens stored at room temperature emerged approximately one month earlier. The adults made a nearly perpendicular tunnel to the surface in completing their emergence.

It is interesting to note that the emergence date of Sphecius closely approximates that of its prey, as was indicated by the concurrent appearance of cicadas at Dayton, Ohio, in 1939 and 1940. As noted later, however, Sphecius does not begin to prey upon cicadas until several weeks after its emergence.

---

[1] Acknowledgements: The writers have been aided in this study by many workers. In addition to those specifically mentioned in the text acknowledgment is made to Mr. Edward S. Thomas, curator of natural history of the Ohio State Museum, Mr. Joseph N. Knull, curator of the Ohio State University insect collection and Mr. Ralph Dury, curator of the Cincinnati Museum of Natural History, for permission to examine specimens of *Sphecius speciosus* and *Tibicen* sp. in their respective museums.

[2] Order Hymenoptera, family Sphecidae, sub-family Bembicinae, tribe Nyssonini.

Feeding and Mating:

The activity of the cicada killer immediately after emergence is apparently not well known. Recent observations only substantiated those of other observers who report that during this period adults feed upon the exudations of various trees including willows, oaks, sycamores, and the flowers of compositae and other plants.

Mating activity occurs concurrently with feeding and may take place far from where burrows are later established, Davis (5). Marked specimens released at Dayton, Ohio, from June 25 to July 3, 1939, were not again observed for at least two weeks. Shortly after their reappearance the excavation of burrows was begun.

Mating has been observed to take place in the air by a number of observers, Davis (5), Denton (7), Manee (11), and the authors. Males perch on exposed vegetation and pursue females which come near. When mating does occur the pair often drop to the ground together but recover quickly. Females have been observed similarly to pursue members of their own sex which makes it difficult to determine if mating is actually taking place. J. W. Sites, however, in conversation, has reported observing a pair of cicada killers quietly copulating while resting on a tall weed in a field near Zanesville, Ohio, July 29, 1940. This pair was so quiet that he was able to capture them easily.

Sex Ratio:

Of 25 adults emerging from stored larval cases, 15 were males and 10 females. Seven specimens collected in Muskingum County were females and of the specimens at the Ohio State University and the Ohio State Museum 29 are males and 37 are females. Denton (7), records obtaining 13 females and 7 males from a group of 20 specimens he collected from a colony on August 2, 1930, at Robbinsville, North Carolina. These collections, totaling 128 specimens, indicate a sex ratio of 70 females to 48 males, or 59.3 per cent females to 40.7 per cent males. During the height of Sphecius activity, however, males are seldom observed.

Digging and provisioning of burrows begins in mid-July and reaches a peak of activity the first two weeks in August. A marked Sphecius released at Dayton on July 3, 1939, was observed cruising back and forth along a lawn terrace on July 17 and began excavating there on July 22. Usually by the first of August there is considerable digging and provisioning of burrows in Sphecius colonies. Although they have been observed to be abundant as early as July 4, at the Eden Township colony in Licking County, their burrows have not appeared in large numbers there until some weeks later.

Location and Description of Colonies:

With few exceptions cicada killer colonies are located in well-drained, light-textured soil, in full sunlight where vegetation is scant or absent. Included in the list of sites studied in Ohio are such locations as: tree seedling and lining out beds at the Marietta and Zanesville tree nurseries, greenhouse flat boxes at Zanesville, a cinder roadbed at Zanesville, tennis courts on the Ohio State University campus, a school yard at Rocky River, a new earth fill in a city yard at Dayton, a formal garden surrounded by a concrete platform at a railroad station at Cambridge, a tobacco field in Clermont County, and frequently in lawns, over-grazed pastures, and old fields in the southern part of the state.

Size of colonies studied varied from one of two burrows to one of 373. The latter colony is definitely known to be at least 9 years old and is probably much older. It occupies an area of approximately one acre of thin pasture. The area occupied is variable and does not seem to be limited by the number of burrows. The distance between burrows ranges from a little more than one foot to 15 feet or more. Burrows in the large colony studied were grouped in units where they averaged 6.9 per 100 square feet.

Digging of Burrows:

Digging of burrows begins before mating activity ceases in the colony and continues throughout the summer until late August. The cicada killer accomplishes excavation by using the mouth parts to dislodge soil and other particles and to cut through roots of plants. The material so removed is pushed under the wasp's body by the fore legs and after a small amount accumulates it is kicked out behind in much the manner employed by a dog. As digging progresses beyond the point where this method is effective the soil is dragged to the surface by the forelegs or is pushed out with the head. The accumulated pile of soil outside the burrow is kept away from the opening and a neat U-shaped entrance to the burrow is maintained. (Fig. 1).

The burrow, when in readiness for the first cicada, is dug usually to a depth of 6 to 10 inches. It measures approximately one-half inch in diameter and from 12 to 18 inches in length from the entrance to its terminus where the first cell is excavated. The rate at which digging progresses probably varies with the soil condition. The rate of digging observed in a well-packed, clay fill at Dayton, Ohio, gives some indication of the cicada killer's digging ability. In this case a tunnel was dug out ready for the first cicada between 2 P. M., July 21, and sometime prior to 8 A. M. July 22. Approximately one-half pint of soil was removed during this period.

Cells in which cicadas are stored are broadly egg-shaped with the long axis in the horizontal plane and perpendicular to the tunnel. They measure approximately 2 inches deep, 1½ inches wide, and slightly over an inch high. The walls of the cells are smoothly shaped and no loose dirt is left on the cell floor. Shaping of the cell is probably accomplished with the same tools as used in excavating the burrows.

Generally, after a cell has been provisioned with a cicada or cicadas, and an egg laid on one of them, it is plugged with a thin wall of earth and a new cell made immediately in front of it. As many as four provisioned cells have been found in one such series. After a cell or series of cells is completely provisioned a new lateral off the main tunnel is excavated and the process repeated. The number of cells fitted per burrow varies considerably but was found to average 15.8.

Hunting and Provisioning Burrows:

The Cicada Killer, like other solitary wasps, Peckham (15), makes no effort to obtain its prey until a cell has been made ready for it. Attempts to alter this habit by placing a healthy cicada at or near the burrow entrance during the digging of the tunnel proved unsuccessful. Equally unsuccessful were attempts to entice Sphecius to attack cicadas tethered with a thread and permitted to fly about their colonies while they were actively working and flying around.

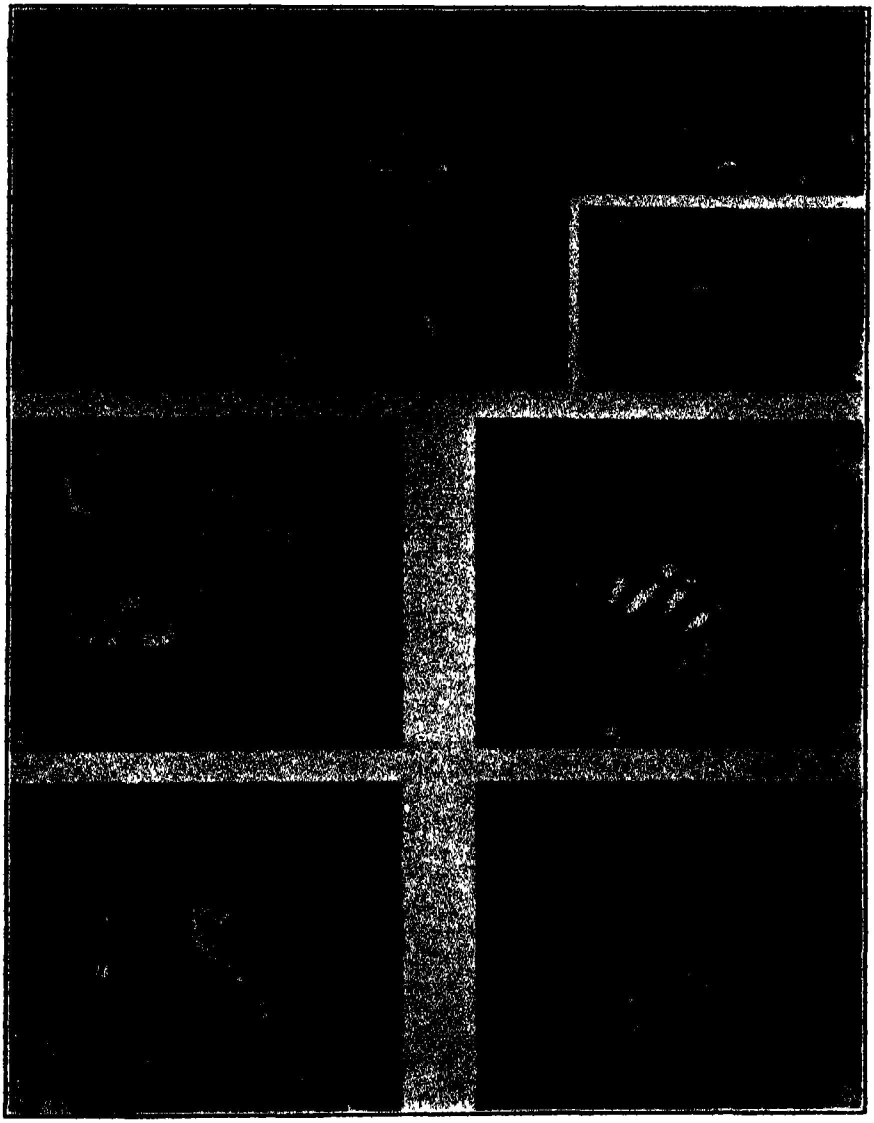
Sometimes before leaving the vicinity of its burrow a wasp would circle around it several times before departing in the direction from which it later returned with a captured cicada. Equally often, however, no preliminary maneuvers were engaged in, the Sphecius simply flying directly toward its hunting territory, or if windy, heading first into the wind and, after gaining a height of 10 to 15 feet, flying in the desired direction.

In hunting, the wasp approaches a tree or shrub and slowly circles closely about the trunk, gradually working its way up through the limbs and branches. It sometimes alights on the bark and continues the search on foot.

The method of attacking cicadas when located has been ably described by Mr. Conrad Roth of Portsmouth, Ohio, (in a letter of August 23, 1939) who witnessed a capture of *Tibicen pruinosa* at close range. "The wasp darted backward and forward in front of the cicada several times meanwhile bending the tip of the abdomen downward and forward. It then hit the cicada viciously and injected the sting between the abdominal segments. The cicada buzzed shrilly and immediately ceased struggling. The wasp managed to hold its prey to the limb of the tree and pulled it up on the top side of the limb. After this effort the wasp turned the cicada over on its back, straddled it, grasped the body firmly and flew off with the burden toward a Sphecius burrow."

In carrying its prey, Sphecius has always been observed to hold it firmly in an inverted position by locking its middle pair of legs about the neck between the eyes and the pronotum, (Fig. 2). Early writers, Riley (18), Smith (20), Marlatt (12), figured Sphecius dragging a cicada right side up. This error was corrected, however, by Davis (5).

Reports have been received indicating that a Sphecius sometimes takes its prey while in full flight. J. N. Knull, in conversation, reported one such capture which he witnessed at Cape Henry, New Jersey. In this instance the wasp hit the cicada while in flight and tumbled to the ground with it. Whether it stung its prey while in the air or after striking the ground was not observed. That this is not the usual method of attack, however, is evident from the apparent safety enjoyed by cicadas observed flying to and from trees 10 to 25 feet in height while cicada killers were busy searching the lower limbs in the usual methodical manner. It is quite likely,



1. A colony of burrows along a cinder roadway.
2. An adult female wasp with a captured cicada.
3. A male and female cicada (*Tibicen lyricen engel.*) stored in a cavity.
4. Egg of wasp on captured cicada.
5. Nearly full grown larva feeding on cicada.
6. Earthen case in which larva overwinters and completes life cycle.

however, that should a cicada attempt escape by flight after being located, pursuit and probably capture would result.

The captured cicada is carried in flight to the burrow entrance from distances sometimes in excess of 100 yards. Usually flight terminates at or within a few inches of the entrance and the cicada is then speedily carried down the tunnel. Less successful landings in grass or other vegetation frequently result in abandonment of the prey as the struggle to drag the burden to the burrow becomes too great. Davis (4), reported an observation by Morse of Sphecius dragging its prey up a maple tree and taking off from a high point after an unsuccessful struggle to reach its burrow through grass on the ground. Similar observations have been recorded by Davis (5), and Manee (11).

Cicadas are placed in the cells on their backs with their heads directed away from the open side (Fig. 3). When more than one cicada is placed in a cell they are laid side by side and all in the same direction. The number of cicadas stored per cell varies between 1 and 3 and averages 1.3.

Species of cicadas stored in burrows usually were those common in the vicinity of the colonies. Their relative abundance was about proportional to that noted from the number of males of each species heard in the immediate vicinity. Table I lists the species taken from colonies, by habitats, for which definite determinations have been made by W. T. Davis. In addition to these species, records of the following have been obtained: *Tibicen robinsoniana* taken from a cicada killer in Adams County, Ohio, August 11, 1935, by Conrad Roth and Edward S. Thomas; *T. marginalis* reported being carried by Sphecius up a telephone pole by Manee (11); and Sphecius hunting in willows in which *T. marginalis* were abundant, reported from Butler County in 1937 by E. E. Good. Davis (5), believed that *T. auletes* is taken also but no records have been found to substantiate his belief. Riley (8), reported the taking of *T. pruinosa* as has also Mr. Conrad Roth of Portsmouth, Ohio. Viereck (22) records it as preying on *T dorsata*, *T. tibicen*, and *T. marginata* based on records by Ashmead.

Probably all of the cicadas with arboreal habits occurring within the range and active season of Sphecius are taken to some extent. *Okanaga rimosa* and the 17-year cicadas, *Magicicada septendecim* (Lin.), and *M. cassini* Fisher, and *Melampsalta calliope*, are too early in their appearance to be taken by Sphecius in Ohio. With the exception of possible stragglers their season is usually over two or more weeks before active hunting by Sphecius begins. Museum records of *Magicicada* in Ohio, for instance, range from May 26 to June 28.

The sex ratio of cicadas stored in burrows is greatly in favor of females. Of 703 Sphecius captured cicadas examined but 204 were males giving a sex ratio of 7 females to 3 males. Davis (5), noted this and in so doing called attention to the erroneous idea prevalent among naturalists that Sphecius secures its prey by hunting only singing males. The disproportionate sex ratio may be due to the greater susceptibility of females to the hunting system employed by the wasp. Male cicadas are probably more readily disturbed than are ovipositing females.

Laying of Eggs and Development of Larvae:

Only one egg is laid per cell irrespective of the number of cicadas it contains. Eggs are cylindrical or cigar shaped, transulcent, greenish-white in color and measure from 3 to 5 millimeters in length. The egg is placed lengthwise snugly under the femur of one of the middle pair of legs, (Fig. 4).

Eggs found on cicadas in the last completed cells in a number of burrows hatched within 24 to 36 hours. Presumably they were only a few hours old as wasps had been observed a short time previously to enter the burrows with cicadas. The newly-hatched larvae began feeding by inserting their mouthparts into the body cavity of the host at the base of a mesothoracic coxal plate. (Fig. 5). As the larva grew its feeding was transferred to the base of each of the remaining coxal plates until nothing remained of the cicada but a skeleton. When more than one cicada was available feeding was continued in the same manner on the second or third specimen.

Growth of the larvae is very rapid. One specimen which hatched prior to 8 A. M. August 29, 1939, had attained a length of 1.6 centimeters 48 hours later, and had completely eaten the body contents of the cicada on which it was feeding in 82 hours. At that time it measured 2.8 centimeters in length when quiet and 3.2 centimeters when extended in feeding. After feeding briefly at the base of one coxal plate of another cicada it became restless and crawled around for several hours. By 8 A. M. September 2, 1939, 14 hours later, it had begun to spin a larval case consisting of a very open framework of thin fibres By 5 P. M. of the same day a thin, silken-like, cylinder-shaped case had been woven which was open at both ends. The larva could easily be observed through this case as it seemingly shellacked the inner surface with a gelatinous substance applied by the mouth parts The larva was observed virtually to crawl over itself in the cramped quarters of the larval case as it applied the finishing touches to the interior. After the open cylinder was apparently completed the ends were spun and sealed shut

The completed larval case was broadly spindle shaped (Fig. 6), measuring 4.4 centimeters in length and about 1.5 centimeters in diameter. Both ends of larval cases are truncated with one noticeably larger than the other. Near the center of the cases a narrow band of outwardly opening pores occurs. The number of pores present in a series of 25 cases varied between 6 and 14 with an average of 10. The exact function of these pores is not known but presumably they represent some sort of respiratory or moisture regulating mechanism.

As the case hardens it becomes earthen-brown, stiff, and capable of withstanding reasonable handling. Soaking in water at room temperature for a half hour did not seem to weaken the cases nor to injure their occupants. Storage of the cases under very moist conditions for several months, however, made them soft, whereas storage in dry sand for the same length of time caused them to become very hard and brittle.

The number of cicadas placed in each cell as food has a direct effect on the size of the larval cases and may have some effect on sex, Clausen (3). In one series of observations 47 cells containing small or medium sized larval cases were found to be provisioned with but one cicada. Cells containing large larval cases in the same set of observations were found to have been provisioned with 2 cicadas in 19 cells and with 3 cicadas in 5 cells Only 2 large larval cases were *found with single cicadas and each of these had a large female T. lyricen.* The average length of 135 larval cases was 3.2 cm. and average width at the widest point was 1.1 cm. The smallest larval case found measured 2.1 cm. in length and 7 cm in diameter. The largest specimen found was 4.7 cm. in length and 1.6 cm. in diameter.

Soon after the case is completed the larvae shrink in size and the skin appears leathery as contrasted to its thin translucent appearance during feeding, (Fig 5). The larvae remain in this quiescent stage over winter and begin pupation about one month before emergence, or the latter part of May. Earliest date of pupation of specimens stored out of doors at Dayton in 1939 was May 25. By the first of June all of the approximately 25 larval cases so stored contained well-developed pupae.

The waning of the cicada population in early September marks the end of the active adult cicada killer's life. By early September few adults can be found and before the first frost they are usually absent in the vicinity of colonies. Apparently neither sex overwinters in the adult stage. The life span of adults is remarkably long for such busy insects, covering approximately 65 days, if the dates July 1 and September 1 are considered mean first and last dates.

Since adults are known to feed only for a short time during the mating period the food assimilated must be used with a very high degree of efficiency to permit their tremendous energy output during the active adult life span.

An approximation of the life history of Sphecius by time intervals has been computed from the data assembled and is about as follows:

Egg.........24–48 hours—Late July through August.
Larva.......4–10 days feeding—Late July through August.
270–310 days quiescent—Late July to June 1.
Pupa..........25–30 days—June 1 to July 1.
Adult—60–70 days—July 1 to mid-September.

BEHAVIOR

In size and apparent aggressiveness the cicada killer appears to be one of the most formidable of North American wasps. It is, however, unexpectedly docile. In the course of this study, specimens have been removed from burrows with forceps, banded with colored thread, and released. Others have been knocked to the ground or brushed from captured cicadas with the bare hands. These and other forms of disturbance have never occasioned even a threatened attack. As has been reported by other observers, however, upon entering a colony, an intruder is sometimes approached in a businesslike manner but with no actual attack resulting.

That Sphecius can and will sting has never been doubted. This was ably demonstrated to one of the writers by a large specimen during capture. The sting penetrated the flesh close to the tip of his right index finger. An initial sharp pain was followed by numbness, a slight swelling, and stiffness which lasted for about a week.

Throughout the summer and during mating activity, the male Sphecius is very aggressive and vigorously pursues various insects and even inanimate objects tossed near his perch, as well as females of the species. In one instance a Sphecius was observed to chase an English sparrow which chanced to fly within 25 feet of his perch. There are some indications that a rather well-defined territory is established by the male, within which all intruders are investigated in a vigorous manner. This territory may well represent the visual limits exciting response in this insect. These guarding activities are not confined to the males, however, as large females have been observed to exhibit somewhat similar behavior.

SOCIAL AND SOLITARY HABITS

The cicada killers are generally considered to be solitary wasps. Nevertheless, they exhibit certain traits of the social insects that are of particular interest. The most obvious of these is their habit of living in colonies made up of individual burrows.

On some occasions more than one female will utilize the same burrow. At the colony in Licking County a marked female was observed freely to enter and leave within a few minutes four different burrows, which were being used by unmarked females. Upon occasion two females have been observed to pass at a burrow entrance, one leaving and the other entering. No show of antagonism was apparent between them. In the same colony 2 females, each in a different cell within the same burrow and each with a cicada on which an egg had been laid, were found August 13, 1940, when one of the writers and Robert Paton were digging out the burrow. On the same date we were able to transfer cicada-laden wasps from the burrow entrance, where they landed, to nearby burrows. When this was done the new burrows were entered immediately. A similar observation was made at the same colony in 1938.

Smith (19), in reporting on a colony of approximately 50 burrows in Philadelphia, Pennsylvania, said that 40 or more individuals were removed without making a noticeable decrease in the number of individuals flying about. Since the sex ratio probably slightly favors females it is apparent that in this colony there must have been many more females than there were burrows.

Observations made to date have not made clear how frequently these apparently social habits occur. It would appear, however, that the habits of this insect are not strictly solitary.

MORTALITY

After larval cases have been formed, losses of Sphecius from natural causes are apparently very low during the normal life span. Losses, however, are very high between the time the eggs are laid and the larval cases are formed. Of 525 cells examined only 201, or 38.28 per cent, contained sound larval cases. The remaining number contained often untouched cicadas, which were frequently covered with mold.

The high mortality is probably due to a number of causes of which only one has been definitely determined. A secondary host relationship was discovered during 1939 between certain flies and Sphecius. Sarcophagid flies observed resting on a mound of earth outside a Sphecius burrow at Cambridge, Ohio, July, 1939, aroused interest in the possibility of such a relationship. Opportunity to investigate was not afforded, however, until similar observations were made in Clermont County, Ohio, in late August of the same year. Subsequent examination of 10 burrows at this location yielded records of one or more cells containing larvae of diptera in the stored cicadas in all but one burrow. Larvae were found in stages of development ranging from newly-hatched maggot clusters to fully-developed puparia.

In some cases both Diptera and the Sphecius larva were feeding on the same cicada. It is evident, from observations made on infested cicadas to which a live Sphecius was still attached, that the fly maggots consumed the available food supply before Sphecius secured sufficient food to complete its development. The smallest number of fly larvae found in a cicada was 16 and the greatest 27. These larvae, when ready to pupate, ranged from .9 to 1.1 centimeters in length. In the 10 burrows excavated, 87 cells containing cicadas were found. Of these, 26 contained healthy appearing Sphecius larvae, 10 contained cicadas infested with fly larvae, two of which had dead Sphecius larvae still present. The remaining 51 cells contained only dead and often decomposed cicadas. In one burrow containing 9 cells at Washington, Indiana, 2 cells contained healthy Sphecius, one contained cicada and fly larvae and the remaining cells contained only dead cicadas.

One adult fly was captured as it rested on a pile of earth excavated from a burrow. Another was captured in a cell containing diptera puparia and 4 additional adults were obtained from puparia collected. The first two specimens and two of the latter 4 were sent to Mr. David G. Hall of the U. S. National Museum. Mr. Hall's determinations are as follows:

Metopia leucocephala (Rossi), *Sarcophagidae*—2.
Zygobothria sp. (probably *incompta V. d. w.*) *Tachinidae*—1.
Chaetoplagia atripennis Coq.—*Tachinidae*—1.

Mr. Hall stated that the two species of Tachinidae are not known to have any connection with fossorial wasps but that the Sarcophagid is a common parasite of these insects.

In view of the indeterminate status of the flies, further study is needed before more data can be presented. It is sufficient for the present to call attention to the records of their relationship to Sphecius survival.

ECONOMIC IMPORTANCE

The cicada-killer has slight economic importance. In the southern part of the state it has been considered a pest in city lawns, gardens, nurseries, greenhouses, and golf courses. In lawns and on golf courses the unsightly piles of earth removed from the burrows are considered objectionable. In gardens, nurseries, and greenhouses, burrows are sometimes made so close to plants that death to the plant ensues. In nurseries the earth removed from burrows when placed on young seedlings is often deeper than the plant can stand and death results. In addition, colonies of this formidable appearing wasp around city homes and playgrounds cause no little fear to the uninitiated.

In no case has the actual damage reported been of much economic importance. Most of its importance in this respect is properly listed as a nuisance factor. Smith (19), reports complete control of a colony of Sphecius by placing a teaspoonful of calcium cyanide at the entrance of each burrow. Blake Hanan reported, in conversation, that a colony established in a schoolyard at Rocky River, Ohio, was eliminated by a liberal application of old machine oil.

Both of these methods have objectionable features: The first because of the poison hazard; and, the second because of its deleterious effect on vegetation and unsightly appearance. It would seem that, where feasible, frequent watering and aiding vegetation to grow thickly by means of lime and fertilizer applications, if necessary for one or two seasons, would prove an effective control measure because a well-drained soil and scant or no vegetation are two requisites of a successful Sphecius colony.

The major beneficial habit of this wasp is its destruction of cicadas. Although the cicadas taken by Sphecius do not reach serious economic importance in this state, they are a destructive insect. That Sphecius can materially effect the population of cicadas is evident from the number of cicadas stored in individual colonies. In one colony of 373 burrows studied in 1937–38 in Licking County, an average of 30.4 cicadas per burrow were found in 13 carefully excavated burrows selected at random, after provisioning had ceased. On this basis the number of cicadas stored in burrows in the entire colony during 1937 numbered 11,339. The area from which they were taken is not known but since most of the species present were *T. lyricen engelhardti*, which occurs commonly in oak-chestnut forests, they presumably came from forest of this type in the vicinity of the colony. The total amount of this type of forest within a quarter of a mile radius of the colony is estimated to be considerably less than 50 acres.

Burial of such large numbers of cicadas over a period of years in a limited area has had a noticeable effect on soil conditions. The most evident effect is the incorporation of organic matter in the soil due to the decomposition of the stored cicadas. Loosening of the soil due to digging of burrows and cavities by the adult wasp is also apparent. Local as these effects are they indicate how myriads of other invertebrates, over a long period of time, have probably added to the formation of vitally important top soil.

TABLE I

CICADAS COLLECTED BY HABITAT AND SPECIES

DATE AND LOCALITY	TYPE OF SITE AND VEGETATION	SPECIES OF CICADA BY NUMBER AND SEX							
		T.canicularis		*T.chloromera*		*T. linnei*		*T. lyricen engel.*	
		♂	♀	♂	♀	♂	♀	♂	♀
Muskingum Co., Ohio. 8-14-34	Abandoned crop field near old field association and 150 yards from oak hickory woods.			3	1	4	0	1	0
Eden Twp., Licking Co., Ohio, Aug., 1937	Closely grazed pasture adjacent to oak-chestnut forest and old fields.	3	0			8	5	5	21
Glen Este, Clermont Co., Ohio. 8-27-39	Old field—partly grown up with elm, beech-maple woods within 150 yards.			4	15	1	0	0	2
Washington, Indiana. 9-21-39	Nursery—sandy soil 100 yards from old fields; 200 yards from oak-hickory woods.			0	8	0	1		
Dayton, Ohio. 8-30-38	New fill—edge of city limits with many abandoned fields within 100 yards.					0	6		
Totals . .	. . . .	3	0	7	24	13	12	6	23
	Totals—old field association.			7	24	5	7	1	2
	Totals—Oak Hickory Chestnut association.	3	0			8	5	5	21

To the students of the *Cicadidae,* Sphecius is a valuable ally. By observing the cicada-collecting habits of this insect much can be learned of the distribution and relative abundance of cicadas. It is possible also, to easily obtain specimens of cicadas in good condition by intercepting the burdened wasps as they return to their burrows. Mr. Conrad Roth reports successfully collecting cicadas by plugging Sphecius burrows in the morning and returning later in the day to pick up specimens left by the returning wasps when they found their burrows plugged. Colonizing of Sphecius in localities where cicada-collecting is desired promises a unique method of collecting. An attempt to establish a colony by storing larval cases in a likely place met with moderate success when tried at Dayton, Ohio, in 1939. Of several females released, one established a burrow within a few yards of the place where the larval cases were stored.

LITERATURE CITED

(1) **Champlain, A. B.** Hunters of the treetops wherein the Cicada-killers do their stuff. Nature Mag. 14: 176, Sept., 1929.

(2) **Clark, A. H.** Potent personalities—Wasps and hornets. Nat. Geo. Mag., July, 1937.

(3) **Clausen, C. P.** Effect of host size upon sex ratio of hymenopterous parasites and its relation to methods of rearing and colonization. Journ. New York Ent. Soc. 47(1), 1-9, 1939.

(4) **Davis, W. T.** Notes of habits of the larger digger wasp. Canad. Ent. pp. 10-11, Jan., 1891.

(5) **Davis, W. T.** Mating habits of Sphecius speciosus, the Cicada killing wasp. Bull. Brook. Ent. Soc. 15: 128-129. 1920.

(6) **Davis, W. T.** Cicada killing wasps and flies. Journ. New York Ent. Soc. 32: 113. 1924.

(7) **Denton, S. B.** Habits of the Cicada-killer. Bull. Brook. Ent. Soc. 26: 35. 1931.

(8) **Felt, E. P.** Notes on the Cicada-killer. New York State Museum Memoir 8, 603. 1906.

(9) **Hungerford, H. B.,** and **Williams, F. X.** Biological notes on some Kansas hymenoptera. Ent. News. 23: pp. 241-260, 1912.

(10) **Leonard, M. D.** Insects of New York Cornell Univ. Agr. Exp. Sta. Memoir 101. Issued 1928.

(11) **Manee, A. H.** Notes on Cicada-killer. Ent. News 26: 266. 1915.

(12) **Marlatt, C. L.** The larger digger wasp. U. S. Bull. Bur. of Ent. 71: 132. 1907.

(13) **Packard, A. S.** Description of Sphecius speciosus. Proc. of Ent. Soc. of Philadelphia. 6. p. 442.

(14) **Peckham, G. W.** and **E. G.** Duration of memory in wasps. Amer. Nat. 21: pp. 1038-1040. 1887.

(15) **Peckham, G. W.** and **E. G.** On instincts and habits of the solitary wasps. Bull. Wisc. Geol. and Natl. Hist. Surv. No. 2, 245 pp. 1898.

(16) **Peckham, G. W.** Wasps solitary and social. Houghton, Mifflin and Co. Boston and N. Y. 1905.

(17) **Rau, Phil.** Wasp studies afield. Princeton Univ. Press. Princeton, 1918.

(18) **Riley, C. V.** The larger digger wasp. Insect life. 4: pp. 248-252. 7 figs. 1893.

(19) **Smith, Floyd F.** Note on damage to formal garden by cicada-killer. Jr. Ec. Ent. 18: 836. 1925.

(20) **Smith, J. B.** Insects of New Jersey. New Jersey State Board of Agr. 1899.

(21) **Smith, J. B.** Notes on some digger wasps. Jour. New York Ent. Soc 9: pp. 29-40, 52-72. 3 pls. 3 figs. 1901.

(22) **Viereck, MacGillivray, Brues,** et al. Hymenoptera of Connecticut. State Geol. and Nat. Hist. Surv. 1916.

(23) **Viereck, R. L.** Hymenoptera in N. Y. State Museum. N. Y. State Museum Bull. 274. 1928.

Visual Mechanisms

This volume is the collected papers of The Symposium on *Visual Mechanisms* on the occasion of the Fiftieth Anniversary Celebration of the University of Chicago, September, 1941. The dozen papers represent almost as many different research interests and fields of investigation in vision. Eight of the papers were presented at the Symposium. Four others were added to the Volume by invitation.

Almost any student of vision will find some important and stimulating paper in the list: Hecht on Energy Relations; Krause on the Chemistry of Visual Purple; Wald on the Vitamins *A*: Gellhorn on Anoxia; Bartley, Neurophysiology of the Optic Pathway; Case, Alpha Waves and Structures; Marshall and Talbot, The General Theory of Sensory Acuity; v. Bonin, Garol and McCulloch, Functional Organization of the Occipital Lobe; Polyak, Anatomy of the Retina; Walls, Visual Cells and Their History; Klüver, Functions of the Geniculo-Striate System; Lashley, Cerebral Organization in Vision. Every student of vision should acquaint himself with this volume. Of course some important investigators are absent from the Symposium and could not supply papers, notes the Editor. To hold such a Symposium and to print this volume in wartime is an achievement. The visual literature is richer for it.—*Samuel Renshaw.*

Biological Symposia. Vol. VII (1942) *Visual Mechanisms.* Ed. by Heinrich Klüver. Jacques Cattell Press, Lancaster, Pa. viii+322 pp., $3.25 list.

A NEW CHRYSOBOTHRIS (BUPRESTIDAE: COLEOPTERA)

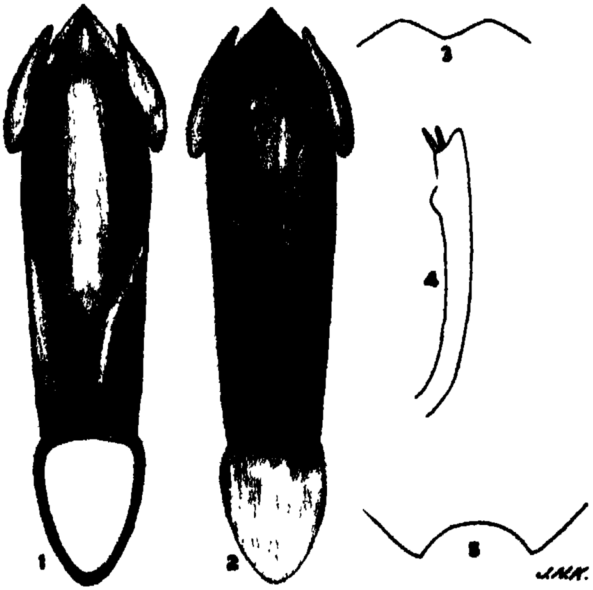
J. N. KNULL
The Ohio State University

Chrysobothris paragrindeliae n. sp.

Male.—Broadly elongate, convex above, dark bronzy brown; front and antennae brilliant green, moderately pubescent throughout.

Head convex; surface lacking callosities or carina, densely coarsely punctured; clypeus deeply emarginate; antennae short, third segment slightly longer than fourth, outer joints wider than long.

Pronotum wider than long, subequal in width at base and apex, widest back of middle; sides broadly rounded; anterior margin sinuate, median lobe broadly rounded; basal margin emarginate each side, median lobe acutely rounded; disk convex, lacking depressions and callosities; surface coarsely punctured, punctures larger than those on head. Scutellum triangular, glabrous.



Chrysobothris paragrindeliae n. sp.
1, Dorsal view male genitalia. 2, Ventral view male genitalia. 3, Clypeus.
4, Anterior tibia. 5, Last visible abdominal sternite.

Elytra wider than widest part of pronotum; sides subparallel to back of middle, then broadly rounded to rounded apices; lateral margins serrulate posteriorly; disk convex, basal depressions deep, humeral depressions shallow; surface densely scabrously punctate; each elytron with two indistinct costae and two foveae.

Abdomen beneath coarsely punctate, each sternite with a smooth callosity on each side along lateral margin; last visible sternite deeply emarginate, lateral margins not serrate. Prosternum with a short broadly rounded lobe in front. Anterior femur with an acute tooth, dentate on outer margin. Anterior tibia arcuate, with obtuse tooth near apex; middle and posterior tibiae straight.

Length—5.2 mm.; width 2 mm.

Described from one male specimen collected at Oak Grove, Calif., June 2, 1941, by D. J. and J. N. Knull, in the collection of the writer.

According to Fisher's arrangement[1] of the genus this species should come after *C. grindeliae* Van D. The structure of the genitalia will separate it from the closely related species.

---

[1] W. S. Fisher, U. S. D. A. Misc. Pub. 470, pp. 1–274, 1942.

TRANSPIRATION IN AMERICAN HOLLY IN RELATION TO LEAF STRUCTURE

C. A. SWANSON[1]

Although the structural leaf type represented by that of American holly (*Ilex opaca* Ait.) is often regarded as an adaptation to xeric conditions, this species of holly, throughout its native range, occurs most frequently in swamps, stream banks, moist woods, and other similarly mesic to hydro-mesic habitats. It appears that American holly, despite its heavily cuticled and coriaceous leaf, is not a drought-enduring species.

Preliminary experiments made by the writer a number of years ago on potted holly plants are also indicative of a low degree of drought-endurance in this species. When drought conditions were simulated in a green house by not adding water to the soil, the holly leaves soon died, becoming brittle-dry. It was noted that the ordinary yellow coleus, with its thin, parenchymatous leaves, would often survive a considerably longer period of soil desiccation than holly.

Interest was therefore aroused in studying further the water relations of American holly under carefully controlled conditions. Since relatively little experimental work has been done on the influence of structural differences in leaves on transpiration rates, the present investigation has been concerned mainly with this phase of the problem.

MATERIALS AND METHODS

Three series of experiments were carried out, involving different comparative materials and methods.

SERIES I. Potted plants of American holly (*Ilex opaca*) and tobacco (*Nicotiana tabacum* var. White Burley), 15–20 inches and 9–12 inches high respectively, were used in this series of experiments. Comparative records of water-loss in these species were obtained on an automatic transpirometer described by Transeau (1911), and the results calculated in terms of grams of water lost per square decimeter of lower leaf surface. The apparatus and plants were mounted on a slowly rotating table which completed one revolution in about two minutes. The pots were sealed in metal jackets, and provided with stoppered tubes for periodic watering and aeration of the soil.

SERIES II. American holly and yellow coleus (*Coleus blumeii*) were compared in this series. By potting the plants in known weights of soil of known moisture content (30% saturation), and periodically restoring to original weight, a more precise control over the factor of soil water content was effected. The method of experimentation was otherwise essentially the same as in Series I, except that only the cumulative water-loss per day was determined.

SERIES III. In order to eliminate the effect of stem and root conducting systems on the rate of water-loss, the experiments of Series I and II were supplemented by a number of studies using single leaves or small shoots, the cut ends being immersed in water, and necessary precautions taken to safeguard against evaporation from the free water surfaces. The plant parts were cut under water, placed in the containers, and allowed to stand for several hours under a bell-jar, in order to insure an equilibrated internal water balance before making the initial weighing. To maintain uniform environmental conditions, the cuttings were mounted on a slowly rotating table during the course of each experiment in the greenhouse. By this method, the observed water-loss is more nearly a function of leaf structure.

---

[1] Paper from the Department of Botany, The Ohio State University, No. 452.

RESULTS AND DISCUSSION

Data are tabulated in Table I to show the comparative leaf structure of holly, coleus, and tobacco. The value R is the ratio of internal to external exposed surface of the leaves, and was calculated by Turrell's method (1936). In Table II the data of experiments in Series I and II, are summarized and the average rates of water-loss expressed in terms of per cent relative to holly. The variability of data obtained in Series III precludes a concise summation of the results, but data for three representative experiments are given in Table III.

It is evident from the data in Table II that the rate of water-loss in American holly was on the average higher than in either yellow coleus or tobacco. These results agree with those of Bergen (1904), Maximov (1929), and others, who have shown that the rate of transpiration in xeromorphic species is often higher than in mesomorphic species.

TABLE I

COMPARATIVE LEAF STRUCTURE

SPECIES	TOTAL THICKNESS OF LEAF	STOMATES / sq. mm.		THICKNESS OF CUTICLE	R
		Upper	Lower		
Am Holly	375 μ	0	220	7-10 μ	12 9
Tobacco	182 μ	90	190	1 μ	7 1
Yellow Coleus	155 μ	0	150	1 μ	4 6

TABLE II

RELATIVE TRANSPIRATION RATES BETWEEN SPECIES

Series	Expt.	Species Compared	Average Relative Transpiration	Duration of Experiment
I	1	holly . tobacco	100 : 91	11 hrs.
	2	holly : tobacco	100 : 87	24
	3	holly : tobacco	100 : 95	32
	4	holly : tobacco	100 : 97	6
II	1	holly : coleus	100 : 67	5 hrs.
	2	holly : coleus	100 :104	12
	3	holly : coleus	100 : 88	12

Turrell (1936) showed that a xeromorphic leaf is characterized by a higher ratio of exposed mesophyll to epidermal surface than a mesomorphic leaf, and suggested that the greater rate of transpiration demonstrated in many xeromorphic species may probably be accounted for in these terms. For *Citrus limonia* and *C. grandis*, Turrell was able to demonstrate a remarkably close correlation. The internal-external surface ratio for *C. limonia* is 1.29 times that of *C. grandis*, and the corresponding ratio of water-loss in rooted cuttings of these species, as calculated from the data of Haas and Halma (1932) was 1.20. This close correlation, however, does not hold for the species used in this investigation; thus, the mesophyll surface exposed per unit external surface in the holly leaves was about 2.8 times as great as that exposed in the coleus leaves, but the average transpiration rate in holly was only 1.2 times as great. Indeed, no close correlation is to be expected, for too many other variables are always present. The greater transpiration rate in *C. limonia*, for example, may have been due in part to a greater root area relative to the transpiring surface. According to Haas and Halma (1932), *C. limonia* produces more roots per cutting than *C. grandis.*

In order to eliminate such variables as the root/shoot ratio, experiments were carried out using single detached leaves, or small cuttings, as described in the methods. Seventeen experiments comprised this series, the results of which were quite variable. Individual variations within the same species may have been due to differences in stomatal behavior Marked differences in the percentage of stomates open on different leaves of the same corn plant have been observed by Sayre (1939). Unfortunately, time did not permit an evaluation of this factor in the present experiments.

TABLE III

Relative Transpiration Rates of Single Detached Leaves

Expt.	Species	Leaf	Water-loss in grams / sq. dm	Average per sq. dm.	Time
1	Holly	1	1.40	1.4	4-7 p. m.
		2	1.14		
		3	1.46		
		4	1.32		
		5	1.70		
	Coleus	1	0.75	0.9	
		2	0.43		
		3	0.92		
		4	1.32		
		5			
2	Holly	1	1.43	1.6	2-5 p. m. Bright sun Temp. 35° C.
		2	1.28		
		3	1.98		
	Lilac	1	1.86	1.0	
		2	0.56		
		3	0.55		
3	Holly	1	0.84	1.5	11 a. m.-7 p. m. Dull, cloudy Temp. 32° C.
		2	1.70		
		3	1.00		
	Lilac	1	3.10	3.3	
		2	3.20		
		3	3.50		

Evidence for a differential behavior in leaves of different species to varying conditions of light is also indicated. Thus under conditions of high light intensity, holly transpired more rapidly than lilac (*Syringa vulgaris*), but under conditions of lower light intensity (as on cloudy days), less rapidly. This difference probably results from differences in stomatal behavior under the two sets of conditions.

A similar effect of variation in light intensity on the transpiration ratio of ***Melissa officinalis*** is shown by the experiments of Mittmeyer (1931). Mittmeyer found that in ***Asarum*** the stomates closed at high light intensities; but remained open in ***Melissa.*** Under these conditions, the rate of transpiration in ***Melissa*** exceeded that in ***Asarum,*** but when the stomates were open in both plants, ***Asarum*** exceeded ***Melissa.***

It seems evident from these experiments and from those of Blaydes (1935) and others, that differences in leaf structure are of little ecological significance in determining differences in transpirational water loss among species. As Shaffner (1928) has pointed out, "the same evolutionary progressions take place whether a group is moving into the water or remaining in the aerial environment." Accordingly, species with thick cuticles, sunken stomates, epidermal hairs, cell mucilages, or a protoplasmic structure capable of enduring desiccation, may be expected to occur in habitats of diverse water relations. From this viewpoint, any correspondence between xeromorphy in plants and drought-endurance would be merely a coincidence.

SUMMARY

The relative rates of transpiration in American holly, tobacco and yellow coleus were determined. Under the same conditions of soil and atmosphere, the holly leaf with its very thick cuticle had an average rate of transpiration which exceeded that of either tobacco or yellow coleus, both with thin cuticles.

The stomatal frequency, when averaged for both upper and lower surfaces, is highest in tobacco, and least in coleus. The internal leaf surfaces of holly, tobacco, and coleus are in the proportion of 12.9, 7.1, and 4.6. No close correlation between relative transpiration rates and the internal surface ratio is evident in these species.

From studies on excised leaves supplied with water, it appears that the relative importance of different leaf structures in affecting the rate of foliar water-loss in different species varies with qualitative and quantitative differences in the environmental conditions to which the leaves are subjected.

The writer wishes to thank Dr. E. N. Transeau for helpful advice in connection with this problem.

LITERATURE CITED

Bergen, J. Y. 1904. Transpiration of sun and shade leaves of *Olea Europaea* and other broad-leaved evergreens. Bot. Gaz. 38: 285–296.

Blaydes, G. W. 1935. Water-vapor loss from plants growing in various habitats. Ohio Jour. Sci. 35: 112–130.

Haas, A. R. C., and F. F. Halma. 1932. Relative transpiration rates in *Citrus* leaves. Bot. Gaz. 93: 466–473.

Maximov, N. A. 1929. The plant in relation to water. George Allen & Unwin, Ltd., London.

Mittmeyer, G. 1932. Studien uber die Abhangigkeit der Transpiration verschiedener Blattypen vom Licht and Sattigungsdefizit der Luft. Jahrb. Wiss. Bot. 74: 364–428.

Sayre, J. D. 1939. Corn stomata. Paper presented before the Plant Institute of the Ohio State University, February 5.

Shaffner, J. H. 1928. Principles of plant taxonomy V. Ohio Jour. Sci. 28: 69–85.

Transeau, E. N. 1911. Apparatus for the study of comparative transpiration. Bot. Gaz. 52: 54–60.

Turrell, F. M. 1936. The area of the internal exposed surface of dicotyledon leaves. Amer. Jour. Bot. 23: 255–263.

THE EFFECT OF pH ON PURE CULTURES OF EUGLENA MUTABILIS[1]

HERMAN VON DACH,
Department of Physiology, Georgetown University
School of Medicine, Washington, D. C.

The extraordinary acid-tolerance of ***Euglena mutabilis*** Schmitz has recently been pointed out by Lackey ('38). He found this green flagellate in abundance in numerous pools and streams polluted by acid drainage from coal mines, at acidities as high as pH 1.8. He stated that this one organism was the most characteristic of the highly acid streams.

Stock cultures of ***Euglena mutabilis***, contaminated by fungi and bacteria, have been maintained in the protozoology laboratory of Ohio State University for several years at pH 3 or 4, in a medium devised by Kostir and Lotze. The present paper gives the results of a quantitative study on the effect of pH on survival and growth of this organism in pure culture.

For accurate experimental work a pure culture was of course indispensable. A single cell of ***Euglena mutabilis*** was washed free of bacteria and fungi by migration in a capillary pipette (a micro-modification of the "migration-pipette" method of Glaser and Coria, '30). A pure clone culture was then established for use in the experiments which followed.

METHODS

The following culture medium, a slightly modified form of the Kostir-Lotze medium, was employed in all experiments:

KH_2PO_4	0.25 gm.
KCl	0.25 gm.
$NaHCO_3$	0.25 gm.
$Ca(NO_3)_2$	1.50 gm.
$MgSO_4$	0.50 gm.
$FeCl_3 \cdot 6H_2O$	0.0004 gm.
$MnSO_4$	0.0002 gm.
Aminoids[2]	0.50 gm.
Triple-distilled water	1000 cc.

Adjustment of pH to the various desired levels was made by adding strong solutions of NaOH or H_2SO_4; then the medium was measured into Pyrex tubes (20 x 150 mm.) and autoclaved.

Three separate experiments were performed. In each experiment, all cultures were inoculated from a single source culture of pH 3.4 whose cell concentration was known. The culture tubes were then incubated at room temperature near a north window. After incubation, three cultures at each pH value were used for making cell counts, microscopic examinations of the cells, and pH determinations. The amount of growth was determined by comparing the concentration of cells per cubic centimeter after incubation (X) with the initial cell concentration (X_0), and expressed as ratio of growth (X/X_0).

The customary bacteriological techniques and tests for purity of cultures were employed. Cell counts were made with a Whipple ocular micrometer and a Sedgwick-Rafter counting cell. Determinations of pH were made after inoculation and after incubation, by means of a Hellige colorimetric comparator and a Leeds and Northrup glass electrode. During the experiments the pH of the various culture series remained constant within 0.1 of a pH unit.

---

[1] Contributions from the Department of Zoology and Entomology, Ohio State University, No. 115.

This work was done while the writer held a Muellhaupt Scholarship at the Ohio State University, 1939-40.

[2] A casein digestive product of the Arlington Chemical Co., Yonkers, N. Y.

RESULTS

Table I gives the results of three separate experiments. These results show that *Euglena mutabilis* survived for at least 12 days over a range of pH 1.4 to pH 7.9. The total range of growth was from pH 2.1 to pH 7.7, with maximum growth between pH 3.4 and pH 5.4.

In Exp. III, cells from the various culture series were examined at one- or two-day intervals. At pH 0.9 all cells were dead within 24 hours. At pH 1.4 (equivalent to approximately N/25 sulfuric acid) some cells remained alive for as long as 12 days, remaining bright green and showing slight but unmistakable movements during this period. At pH 1.9 some cells remained alive for 13 days.

Euglena mutabilis tolerates a greater hydrogen-ion concentration for survival and for growth than any protozoan in pure culture previously reported. (See tables of pH-growth relationships, Loefer, '35, p. 220; Calkins and Summers, '41, p. 540.)

TABLE I. EFFECT OF PH ON EUGLENA MUTABILIS CULTURES

X_0 = initial number living cells per cc.
X = number living cells per cc. after incubation.
X/X_0 = ratio of growth.
X_0 in Exp. I = 100 cells per cc.
Exp. II = 30 cells per cc.
Exp. III = 335 cells per cc.

pH	X/X_0 AT 12 DAYS			X/X_0 AT 24 DAYS		
	Exp. I	Exp. II	Exp. III	Exp. I	Exp. II	Exp. III
0.9	....	—*	—*	....	—*	—*
1.4	<1	—*	<1	—*	—*	—*
1.9	<1	....	<1	—*	....	—*
2.1	....	....	20	....	....	90
2.4	16	42	....	74	372	
3.4	62	210	....	165	644	.
4.0	....	218	....	....	680	
4.2	65		....	158	....	
4.8	....	193	....	....	793	....
5.4	....	144	....	....	704	....
6.0	4.8	....	....	4.6	....	.
7.7	1.9	2.9	....	2.2	2.1	
7.9	....	<1	....	....	—*	
8.2	....	—*	....	....	—*	

* No living cells present.

SUMMARY

In pure clone culture in an organic medium, *Euglena mutabilis* survived for at least 12 days over a range of pH 1.4 to pH 7.9. Its total range of growth was from pH 2.1 to pH 7.7, with maximum growth between pH 3.4 and pH 5.4.

LITERATURE CITED

Calkins, G. N., and F. M. Summers. 1941. Protozoa in biological research. New York.

Glaser, R. W., and N. A. Coria. 1930. Methods for the pure culture of certain protozoa. Jour. Exp. Med., vol. 51, p. 787.

Kostir, W. J., and J. C. Lotze. Unpublished data.

Lackey, J. B. 1938. The flora and fauna of surface waters polluted by acid mine drainage. Public Health Reports, vol. 53, p. 1499.

Loefer, J. B. 1935. Relation of hydrogen-ion concentration to growth of Chilomonas and Chlorogonium. Arch. f. Protistenk., vol. 85, p. 209.

THE OHIO JOURNAL OF SCIENCE

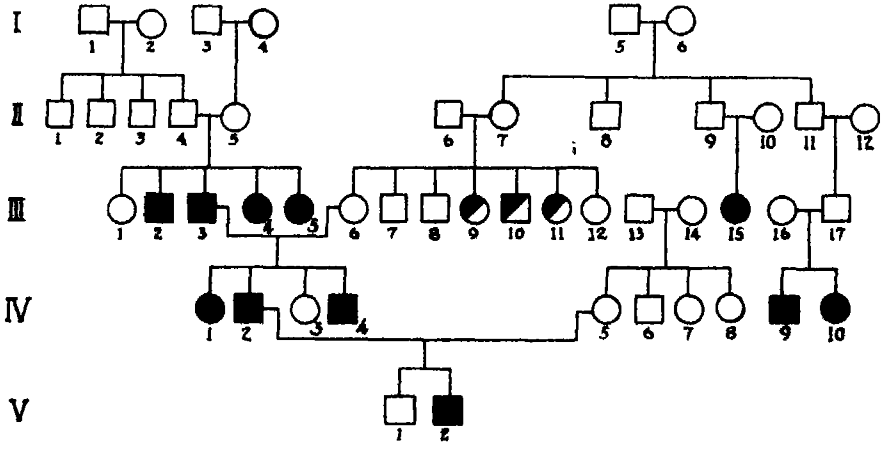
VOL. XLIII MARCH, 1943 No. 2

STUDIES IN HUMAN INHERITANCE

XXII. THE INHERITANCE OF CONGENITAL PYLORIC STENOSIS

LAURENCE H. SNYDER
The Ohio State University

In a recent issue of this Journal (Vol. XXXIV, No. 1, Jan., 1943), Cockayne and Penrose discussed the genetics of congenital pyloric stenosis. They concluded that the condition is a recessive diathesis, that males are more susceptible than females, and that the first-born child is more susceptible than children born afterwards in the same sibship. In the recorded cases Cockayne and Penrose find a low familial incidence and relatively few pedigrees containing more than one affected child.



Pedigree of congenital pyloric stenosis:

III—2, Died of pyloric stenosis at 5 months. 3, Recovered from pyloric stenosis. 4, Died of pyloric stenosis at 5 months. 5, Died of pyloric stenosis at one day. 9, Died at two months, cause undetermined. 10, Died at three days, cause undetermined. 11, Born dead. 15, Died in infancy of pyloric stenosis.

IV—1, Died of pyloric stenosis at 8 days. 2, Recovered from pyloric stenosis; father of propositus. 4, Died of pyloric stenosis at 9 months. 9, Died of pyloric stenosis in infancy. 10, Recovered from pyloric stenosis.

V—2, Propositus; operated on for pyloric stenosis; recovered.

There has recently come to my attention a pedigree of congenital pyloric stenosis which provides interesting additional data (figure 1). The diagnosis of the propositus (V, 2) was confirmed at operation. The diagnoses of all other affected members were made on the basis of similarity of symptoms, which are very striking (projectile vomiting, constipation, gastric peristalsis, etc.).

Cockayne and Penrose recorded from their data a male to female ratio of six to one among affected cases. In the pedigree presented here there were six affected males and five affected females: no significant departure from equality. Moreover, Cockayne and Penrose state that on the basis of their data, a female who is not first-born stands very little chance of being affected. In the family under discussion here, however, only two of the five affected females were first-born, one was second-born, one was third-born and one was fourth-born.

Primogeniture has been suggested more than once as a contributing cause to congenital pyloric stenosis. The critical evidence necessary to establish this, namely, that children born after the patient are almost always normal, has never been produced. The pedigree herewith presented contains strong evidence against the causal nature of primogeniture. The birth orders of the affected children in figure 1 are as follows:

First-born: three, one of whom was an only child, one of whom was followed by one affected sib, and one of whom was followed by an affected sib, then by a normal sib, and finally by another affected sib.

Second-born: four, in two of which cases the first-born also was affected.

Third-born: one, in which case the first-born was normal, the second-born affected.

Fourth-born: two, in one of which cases the second-born and third-born also were affected, and in the other of which the first-born and third-born were similarly affected.

Fifth-born: one, in which case the second-, third- and fourth-born also were affected.

Cockayne and Penrose recorded an increased tendency to hare-lip and cleft palate in the families of patients. In the family presented here, there were two cases of cleft palate, namely II, 8 and a third cousin of IV, 4 not shown in the chart. No consanguineous marriages occurred in the pedigree shown in figure 1.

The data presented here are consistent with the hypothesis that congenital pyloric stenosis is due to an autosomal recessive gene substitution, but these data do not support the contention that primogeniture is a contributing cause, nor do they support the conclusion that males are more susceptible than females.

LITERATURE CITED

Cockayne, E. A., and **L. S. Penrose.** 1942. The Genetics of Congenital Pyloric Stenosis. Ohio Journal of Science, 43: 1–16.

Parasites of Humans

Will Rogers once wrote Will Durant that there seems to be no way to keep people from writing books. But if the high quality of the flood of textbooks in parasitology continues, even more of them will be welcome. Americans are rapidly becoming "parasite conscious" as American citizens are going to all parts of the world and to many places famous for diseases caused or transmitted by animal parasites.

This latest book is a brief account of important human animal parasites and the diseases they cause. There are two sections: one is general considerations and the other is infections caused by protozoa, flukes, tapeworms, nematodes, and arthropods. The information is modern and written so that very little zoological information is required of the reader. The illustrations are a departure from what might be anticipated in that most of them are photographs. The part, of slightly more than fifty pages, dealing with infection, epidemiology, natural resistance and acquired immunity, diagnosis, specific therapy, and prophylaxis, deserves special mention, for these topics are handled in superb fashion. The entire book is of high quality in content and appearance and is intended for medical students and physicians.—*Carl E. Venard.*

Medical Parasitology, by James T. Culbertson. xvi+285 pages, Columbia University Press, Morningside Heights, New York. Sept., 1942. Price, $4.25.

STRUCTURE AND RELATIONSHIP OF CINCINNATIAN CYRTOCERINA

ROUSSEAU H. FLOWER,
University of Cincinnati

INTRODUCTION

None of the three species currently referred to the genus *Cyrtocerina* Billings have been subjected to more than a superficial morphological examination. The present work deals with the investigation of *Cyrtocerina madisonensis* (Miller) formerly regarded as the only representative of the genus in the Cincinnatian. The specimens which have been included under that name in the collection of the University of Cincinnati Museum, and which form the basis of this study, proved on examination to include four species, three of which were closely related and evidently typical of *Cyrtocerina*. The fourth species, externally homeomorphic with *Cyrtocerina*, is referred with question to *Wetherbyoceras* Foerste, though as pointed out below, it probably represents a separate but allied genus now in process of description on the basis of better preserved Chazyan material.

These taxonomic details completed, there remains the more fascinating problem of the structure and affinities of *Cyrtocerina* itself. The vestigial septal necks and the inflated connecting rings are features which at once proclaim the relationship of this genus with some of our earliest cephalopods, those previously placed by the writer (1941), in the Eurysiphonata of Teichert (1933). As these forms are still rather inadequately known, it is not possible to determine the relationship of *Cyrtocerina* very precisely. It differs from all other post-Canadian genera in internal structure, and is quite probably related to *Levisoceras* Foerste, a genus which has not as yet been studied as closely as is desirable for comparison with *Cyrtocerina*. Ulrich and Foerste (1933) have referred *Levisoceras* to the Diphragmida, a group of cephalopods found in the Gasconade and earlier strata, and characterized by diaphragms or tabulae which cross the cavity of the siphuncle. *Cyrtocerina* clearly possesses no such tabulae, but if *Levisoceras* is properly placed in the Diphragmida, as seems probable from the meagre published evidence, *Cyrtocerina* is the only post-Canadian genus which can be traced directly to that group of cephalopods.

I am indebted to Mr. Clifton Smith, student assistant in the University of Cincinnati Museum, for assistance in the preparation of photographs. The expense of illustrative materials as well as part of the cost of the plates has been met by the Faber Publication Fund of the University of Cincinnati Museum.

Cyrtocerina Billings

Genotype: *Cyrtocerina typica* Billings

Cyrtocerina Billings, 1865, Pal. Foss., Geol. Surv. Canada, p. 178
Barrande, 1867, Syst. Sil. de centre de la Boheme, vol. 2, pt. 1, p. 451.
Hyatt, 1884, Boston Soc. Nat. Hist., Proc., vol. 22, p. 266.
Miller, 1889, N. Amer. Geol. Pal., p. 436
Holm, 1892, Geol. Foren. Stockholm, Forh., vol. 14, pp. 126, 209.
Clarke, 1897, Geol. Minnesota, vol. 3, pt. 2, p. 774.
Hyatt, 1900, Zittel-Eastmann Textb. Paleont., vol. 1, 1st ed., p. 517. (Reprinted with different pagination in later editions.)
Foerste, 1924, Denison Univ. Bull., Sci. Lab., Jour., vol. 20, p. 198.
Foerste, 1925, *Ibid.*, vol. 21, p. 11.
Foerste, 1933, *Ibid.*, vol. 28, p. 138.

Conch a rapidly expanding short cyrtoceracone, the aperture uncontracted Section compressed, the convex dorsal (antisiphonal) side frequently obscurely angulate. Sutures are straight and transverse. The siphuncle is located close to the concave side of the conch, generally assumed to be ventral in such cephalopods. The siphuncle itself expands rapidly, being conical in form. The septal necks are vestigial, the connecting rings thickened and more or less produced into the cavity of the siphuncle in each segment. Their complex structure is described in the morphological section of the present work. The aperture has not been observed. Coarse rugose lines of growth indicate that there is no hyponomic sinus developed.

Discussion.—The short rapidly expanding endogastric conch of this Ordovician genus is not closely similar to that of any contemporaneous form, but instead is similar to *Levisoceras* and perhaps also comparable to *Shelbyoceras* of the Upper Cambrian and Basal Ordovician. Those genera are regarded as possessing diaphragms crossing the cavity of the siphuncle. No post-Canadian genera are known which are strictly comparable. On the basis of the exterior alone, *Cyrtocerina* might be confused with immature fragments of *Diestoceras*, but study of the interior will at once show the difference, as *Diestoceras* is cyrtochoanitic and actinosiphonate. The species described below as *Wetherbyoceras? cyrtocerinoides* Flower, n. sp. is similar to *Cyrtocerina* in aspect, but this is also cyrtochoanitic. Both *Wetherbyoceras* and *Diestoceras* can be distinguished not only by the difference in the structure of the siphuncle, but also by the relatively deep camerae, even in small fragments of early parts of the conchs of any known representatives of these genera.

Billings erected *Cyrtocerina* for the reception of short rapidly expanding conchs which were characterized by a large siphuncle on the dorsal (concave) side of the shell. Besides the genotype, *C. typica*, from the Middle Ordovician of the Paquette Rapids of the Ottawa River, he included in it *Cyrtocerina mercurius* Billings (1865, p. 193, fig. 179) of the Quebec group. Miller and Faber (1894) referred to the genus a species previously described as *Tryblidium madisonense* Miller from the Hitz layer, of Whitewater age, at Madison, Indiana. Clarke (1897), added *Cyrtocerina schoolcrafti* from the Decorah formation of Black River age of Minnesota. Foerste (1925) separated *C. mercurius*, making it the type of the new genus *Levisoceras* which he states is "apparently holochoanoidal in structure" while *C. typica* "is distinctly an ellipochoanoidal species." This was written at a time when Foerste regarded all Canadian or older cephalopods as holochoanitic, a view which he abandoned upon further investigation Ulrich and Foerste (1933, p. 289), later reported that the necks of *Levisoceras* were *aneuchoanitic*, that is, terminating at the margin of the siphuncle with only vestigial curvature apicad, and that the interior of the siphuncle contained diaphragms. Upon this basis they placed *Levisoceras* in the Diphragmida. As shown below, *Cyrtocerina* is now known to agree closely with *Levisoceras* both in the form of the septal neck and the general appearance of the connecting ring, but clearly it does not possess diaphragms.

Cyrtocerina differs from all other post-Canadian cephalopods in the rapidly expanding form of the shell, the compressed section, and the position of the siphuncle close against the concave side of the shell. There is as yet no good criterion to show whether the siphuncle is dorsal in position as Billings assumed in writing the original description of the genus, or whether the conch has been curved endogastrically, so that the concave side is ventral, as Foerste believed, I have, in the following descriptions, retained Foerste's orientation, though out of regard to current usage rather than out of any conviction on the matter. The lines of growth of the surface fail to show any evidence of a hyponomic sinus by which the venter may be determined. No specimens have been found yielding either the ventral conchial furrow or the dorsal septal furrow which may be regarded as reliable criteria of orientation. (Flower, 1939, pp. 13-16.)

Knowledge of the internal structure of *Cyrtocerina* is based exclusively upon the Cincinnatian species discussed below, notably upon *C. madisonensis* (Miller) and *C. modesta* Flower. While there is every reason to believe that the genotype is similarly constructed, the conditions under which it is preserved are not favorable for the study of structural details. *C. typica* is apparently a very rare species. It is known to the writer only from Billings' type, which is preserved in the collections of the Victoria Memorial Museum at Ottawa. This is an exceedingly fragile silicified specimen from which all matrix has been removed by careful etching.

In all essential features it agrees with the Richmond species insofar as they can be observed. The large conical siphuncle is close to the concave side of the conch. Its interior presents a faintly annulated appearance. In considering this form as ellipochoanitic, Foerste probably regarded the constrictions as representing the septal foramina. However, in the light of the structure of *C. madisonensis*, it seems much better to regard the constrictions as the connecting rings which are produced in an annular manner into the cavity of the siphuncle. Even should material of the genotype be available which was contained in matrix and suitable for sectioning, it is to be feared that little more could be learned. Shells in that limestone are extensively replaced by silica. While this makes possible the removal of remarkably perfect specimens by means of etching, it has so altered original shell structure that thin section study of the material is profitless, and often opaque sections fail to show structures clearly.

Cyrtocerina is unknown in strata older than the Black River. *C. schoolcrafti* Clarke occurs in the Decorah formation of Black River age in Minnesota. *C. typica*, of the Paquette Rapids, occurs in a limestone which was formerly regarded as Black River age. Kay, however, regards the beds as belonging to the Rockland, lower Trenton, though his reasons for doing so have not been published The genus is unknown in strata of higher Trenton or Covington age, and reappears only in the Whitewater formation near the top of the Richmond of Indiana. The three Richmond species, *C. madisonensis* (Miller) *C. patella* Flower and *C. modesta* Flower are best developed in the "Hitz layer," the southward thinning edge of the Upper Whitewater strata just above the Saluda beds at Madison, Indiana. One specimen was collected by the writer in the Whitewater strata at Versailles, Indiana. No representatives of the genus are known occurring either farther north or east.

This distribution suggests that *Cyrtocerina* belongs to that group of genera which appeared in eastern North America in Middle Ordovician time, then disappeared, presumably to arctic waters, to reappear in the east only near the close of the Richmond. The genus has not yet, however, been found in any of the strata laid down within the Late Ordovician Arctic embayment.

Cyrtocerina madisonensis (Miller)

(Pl. 1, figs 3-4, 12-14; pl 2, figs. 1, 3-7, 9.)

Tryblidium madisonense Miller, 1894 (adv. sheets, 1892) 18th Rep. Indiana Dept. Geol. Nat. Res., p. 318, pl. 9, fig 38.

Cyrtocerina madisonense Miller and Faber, 1894, Cincinnati Soc. Nat. Hist., Jour., vol. 17, p. 32.

Original description.—"Shell medium size; apex high and almost straight above the anterior line of the shell; the shell slopes from the apex and arches a little toward the posterior part of the shell, but laterally and in front it descends abruptly to the margin; transverse section ovate; surface marked with fine, close, concentric lines and a few coarser ones, all of which appear to indicate lines of growth, instead of surface ornamentation; internal scars unknown.

The high apex and anterior portion of it seem to distinguish this species.

Found by J. F. Hammell, in the Hudson River Group, at Madison, Indiana, and now in his collection."

As can be seen, the *Cyrtocerina* was at first described in terms of a *Tryblidium*, a not unnatural error in dealing with a specimen of this peculiar cephalopod genus which failed to show any trace of the phragmocone. However, subsequent specimens showing the phragmocone caused Miller and Faber to revise the original description. Their revised description is quoted, as upon it depends the problem as to the exact identity of *Cyrtocerina madisonensis:*

"At the time one of the authors described, for the Eighteenth Indiana Report (Adv. Sheets Eighteenth Rep. Geo. Sur. Ind., p. 64) a fossil under the name of *Tryblidium madisonense* the internal part of it was not disclosed by the specimen at hand, while the external shell was remarkably well preserved and looked like that of a gastropod, and the form was that of a rather high Tryblidium. There was nothing in the shape or external appearance that would create the slightest suspicion that it belonged to the Cephalopoda. After that time specimens were collected showing a short, very rapidly tapering siphuncle, terminating on the concave side, below the apex and occupying the same position as the siphuncle in Cyrtocerina. Prof. Geo. C. Hubbard was the first to find that it was a chambered shell and possessed a siphuncle, and an examination of his specimens by the author led him to the conclusion that it is a true Cyrtocerina. The chambers are short, though longer than they are in *Cyrtocerina typica*, and the shell expands somewhat more rapidly than it does in that species.

"Heretofore there have been only two species known in this genus. The oldest, *Cyrtocerina mercurius*, from the Taconic rocks, the most elongated species and having the shorter septa, and *Cyrtocerina typica*, from the Black River Group. The species here under consideration is from the extreme upper part of the Hudson River group, which gives a range to this genus, commencing below the Silurian rocks and extending to the very top of the Silurian system."

Previously only this one Cincinnatian species of *Cyrtocerina* has been recognized, a species which marks the upper Whitewater beds above the Saluda, and is typically known from Madison, Indiana, though I have collected it as far north as Versailles, Indiana. Examination of the specimens that had been included under this name revealed that two genera were involved. One of these was characterized by the conical siphuncle noted in the description of Miller and Faber, and agrees closely with the original and revised descriptions. It was evident then, that *C. madisonensis* was among those forms which possessed a siphuncle similar to that of the genotype of *Cyrtocerina*. However, even among these specimens three distinct groups were recognizable on the basis of section and rate of expansion of the shell. Had there been but two, I should have been tempted perhaps to regard them as sexual dimorphism within a single species. However the three forms are sufficiently distinct to describe them as distinct species. The problem then arose as to which of these is identical with the original of *Cyrtocerina madisonense*, the type of which I was not able to locate. Fortunately the original description and figure furnish data by which this matter can be settled beyond any reasonable doubt. The ventral (siphonal) side of the conch must be straight or nearly so; the antisiphonal side must be curved, the curvature increasing as the aperture is approached. On this basis it is quite simple to select among the three species the one which was almost certainly the original of *C. madisonensis*. *C. patella* is a much larger form and one which expands more rapidly throughout. *C. modesta* is a much more slender form in which the curvature of the antisiphonal side is nearly uniform throughout, and in which the section is not nearly as compressed as in either of the other two associated species.

Revised description.—Conch rapidly expanding, compressed in section, the dorsal (antisiphonal) side faintly convex in the early portion, later becoming more curved, so that the rate of expansion decreases orad. The ventral (siphonal) side is nearly straight, probably slightly concave in the extreme apical portion, and becomes very faintly convex as the gerontic camerae are approached. The best preserved of our specimens has an initial height of 4 mm., expands to 25 mm., in the basal 12 mm., beyond which the increasing convexity of the siphonal side reduces the rate of expansion. At a height of 29 mm. the shell has a width of 25 mm. The lateral outlines are slightly convex; the section is compressed with the antisiphonal side the narrower of the two, obscurely angulate, and ridged when viewed adaipcally. The living chamber is very imperfectly known.

The septa are very closely spaced throughout the conch, the sutures tend to slope orad on the antisiphonal side as the aperture is approached. The siphuncle is conical, 1 mm. in diameter where the shell height is 10 mm; and 8 mm. at a shell height of 36 mm. The siphuncular structure is described in detail in another section of this paper.

Types.—Hypotypes, University of Cincinnati Museum, nos. 23965, 23966.

Occurrence.—From the Hitz layer of the Whitewater formation of the Richmond, from Madison, Indiana.

Cyrtocerina patella Flower, n. sp.

(Pl. 1, figs. 1, 5, 8.)

This shell is very rapidly expanding initially, and the convexity of the antisiphonal side increases only slightly, and at a much later stage than in *C. madisonense*. The conch expands in the basal 11 mm. to 24 mm. and 21 mm., the venter (siphonal side) straight, the dorsum only faintly convex, and the lateral outlines straight and rapidly diverging. A second specimen, consisting of a portion of a mature living chamber and gerontic camerae expands from 22 mm. and 25 mm. to a width of 40 mm. and an estimated height of from 45 mm. to 48 mm. in a length of 23 mm. The aperture is not preserved.

The phragmocone shows no features strikingly different from those of the above species. The camerae are exceedingly closely spaced gerontically, eight or nine occurring in the last 5 mm. of the siphuncle. The siphuncle is conical, close to the concave side of the shell. At conchial diameters of 22 mm. and 25 mm. it is 4.8 mm. wide and 5.2 mm. high.

Types.—University of Cincinnati Museum, Holotype, No. 23967, paratypes, No. 2638, 23968, 23969.

Occurrence.—The holotype is from the upper beds of the Whitewater formation from the road cut just east of the limits of Versailles, Indiana. The paratypes are from Madison, Indiana.

Cyrtocerina modesta Flower, n. sp.

(Pl. 1, figs. 2, 6–7; Pl. 2, figs. 2, 8.)

This species differs from the associated *C. patella* and *C. madisonensis* by its much more slender form and broader section. The ventral side is obscurely flattened, the dorsum obscurely ridged. The dorsal profile is slightly and evenly convex throughout, the venter is slightly convex, though nearly straight. The conch increases to a width of 22 mm. and a height of 24 mm. at a distance of about 23 mm. from the apex. At comparable distances from the initial point, both other species have sections both higher and broader. The lateral outlines are slightly and uniformly convex like those of the dorsum and venter. The siphuncle is close to the venter. The camerae are possibly slightly deeper than those of the other species. The form of the conch is best recognized from the accompanying illustrations.

Discussion.—The three specimens upon which this species is based vary somewhat in proportions, owing largely and perhaps entirely to distortion. One specimen is slightly compressed by pressure, but slightly obliquely compressed, so that the tip of the siphuncle is exposed by weathering on one lateral surface.

Types.—University of Cincinnati, No. 17170, holotype; No. 23970-71, paratypes.

Occurrence.—From the Hitz layer of the Whitewater formation, Madison, Indiana.

Wetherbyoceras? cyrtocerinoides Flower, n. sp.

(Pl. 1, figs. 9–11.)

Associated with the species of *Cyrtocerina* described above, is a small portion of a phragmocone which resembles members of that genus very closely in rapid expansion, the apparent endogastric position of the siphuncle, and the development of a compressed antisiphonal side. Nevertheless, sections revealed that the siphuncle was cyrtochoanitic, and that this specimen represents a hitherto unrecognized species. Probably also it represents an undescribed genus, though one which is known to the writer from other material, and is related to *Wetherbyoceras* Foerste, to which I tentatively refer this form.

The conch is compressed initially, with dorsum and venter equally rounded, with a hieght of 21 mm. and a width of 16 mm. In a siphonal length of 16 mm. and an antisiphonal length of 18 mm., the conch increases to a height of 33 mm. and a width of 29 mm. The greatest width of the shell is attained ventrad of the center of the section, and the dorsal (antisiphonal) side is much narrower than the siphonal side. All profiles of the conch are straight. The antisiphonal side is more strongly inclined from the line normal to the plane of the septa than is the siphonal side, giving the shell an endogastric aspect.

Five camerae and part of a sixth are preserved. The septa are shallow, the sutures apparently straight and transverse. The marginal siphuncle is crytochoanitic, the segments broadly expanded, rounded, strongly assymetrical vertically, as in many cephalopods with marginal siphuncles. The apical end of the connecting ring is broadly adnate to the septum on the ventral side, but free dorsally. At the adoral end of the segment, expansion is more marked on the dorsal than on the ventral side, but the brims are short and free on both sides. Small annulosiphonate deposits are found within the siphuncle. No trace of actinosiphonate structure is shown on this specimen. The surface of the shell is unknown.

Discussion.—This fragmentary specimen is very similar in aspect to one which Foerste figured and described as *Ooceras?* sp. from the Whitehead formation of Gaspé (Foerste, 1936, p. 381, Pl. 56, fig. 9.) The two species are almost certainly congeneric. Foerste remarked upon the similarity of his form with *Ooceras seelyi* and *O. lativentrum* as figured by Ruedemann (1906, pp. 496–499, Pl. 38, fig. 7–9). These species form the nucleus of a considerable group of Chazyan species for which a new generic name will be proposed at another time. These cephalopods are characterized by organic deposits within the siphuncle which may be apparently annulosiphonate in small or immature individuals. Some species never pass beyond the annulosiphonate stage, but large species finally attain deposits which are actinosiphonate and strongly reminiscent of *Minganoceras* Foerste (1938, pp. 104–5, Pl. 24, fig. 1–4). This genus appears again in the Platteville limestone, but does not appear again in the American section until found in the Whitewater formation of Indiana and the Whitehead formation of Gaspé. However, subsequent study of the little known genus *Wetherbyoceras*, the living chamber of which is still unknown, has shown that that genus is closely related to this one, so I tentatively refer the species to that genus. This does not, however, imply that *W? cyrtocerinoides* is at all closely related to either *W. valandighami* or *W. conoidale*, which are Covington species. The peculiar type of preservation of the deposits noted by Foerste in his species and in the Chazyan forms also, is not as startlingly displayed in the Cincinnatian species. There is, however, some indication of this mode of preservation in our specimen, which is not confined to the genus, but is widespread among fundamentally actinosiphonate cephalopods and has been noted by the writer in *Diestoceras*, *Cyrtacleistoceras*, *Minganoceras*, and *Archiacoceras*.

Type.—Holotype, University of Cincinnati Museum, No. 23971.

Occurrence.—Hitz layer, Upper Whitewater, Richmond group. From Madison, Indiana.

STRUCTURE OF THE SIPHUNCLE OF CYRTOCERINA

Opaque sections (Pl. 1, fig. 13, pl. 2, fig. 5) show that the siphuncle expands rapidly within the conch, taking on a conical form. The septal necks appear to be very short or wanting, and the interior of the siphuncle appears to be lined with an annular deposit. This differs from the usual annulosiphonate deposits in that the cavity of the siphuncle is constricted at the middle of each segment of the siphuncle, whereas normal annulosiphonate structure causes the constrictions to be located at the level of the septal foramina.

The same specimen in thin section (Pl. 1, fig. 12, 14; Pl. 2, fig. 1, 3, 4, 6, 7, 9) shows that the structure is quite unlike that of any known contemporaneous cephalopod. The septa are properly aneuchoanitic, that is, they terminate at the

EXPLANATION OF PLATE I

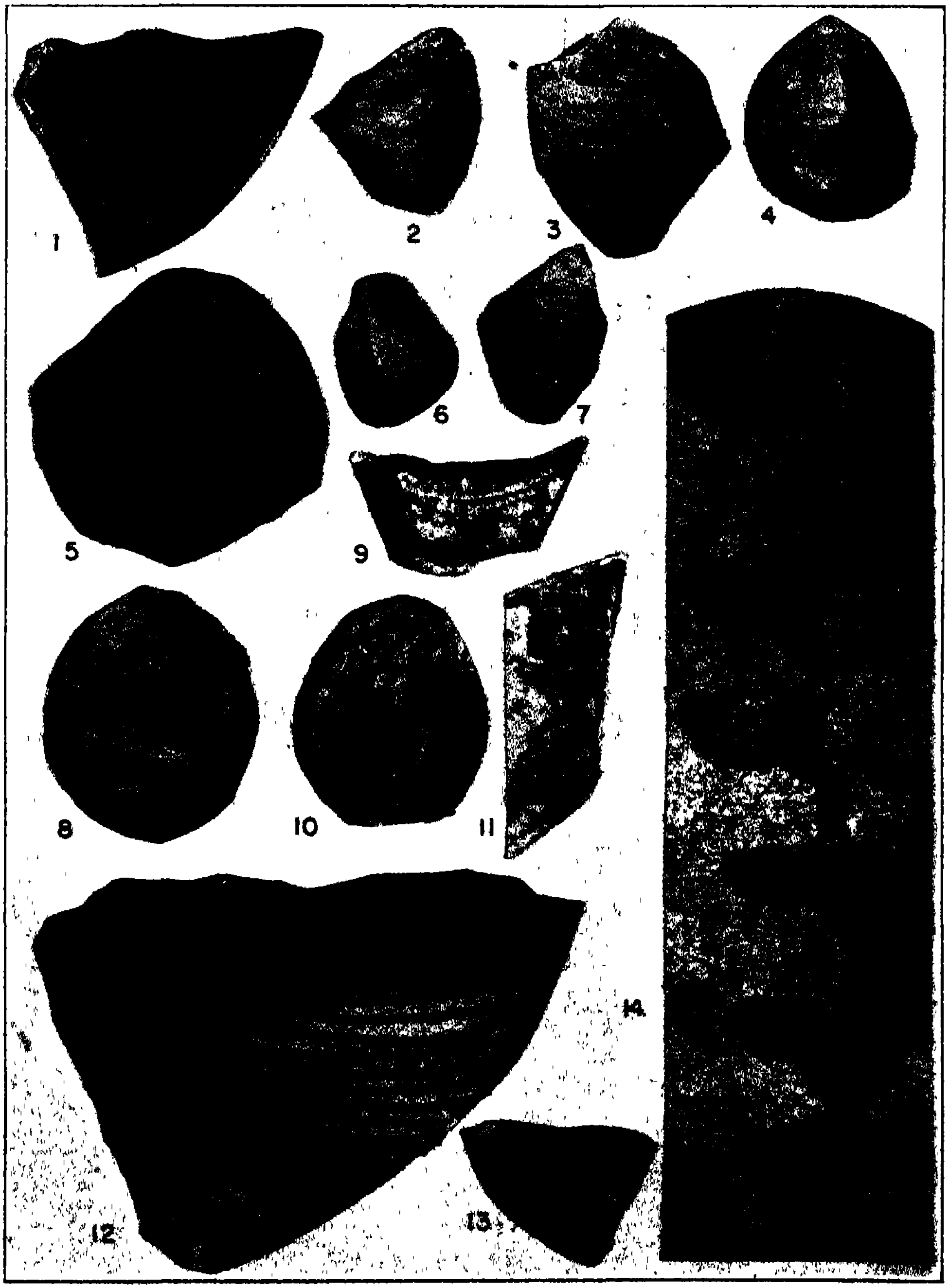
Cyrtocerina patella, Flower, n. sp. (1) Composite specimen showing vertical section of holotype (No. 23967) adorally, and unsectioned paratype adapically (No. 2368). (5) adapical view of holotype. (8) adapical view of paratype, No. 23968. Upper Whitewater formation. Holotype from Versailles, Indiana, other specimens from Madison, Indiana.

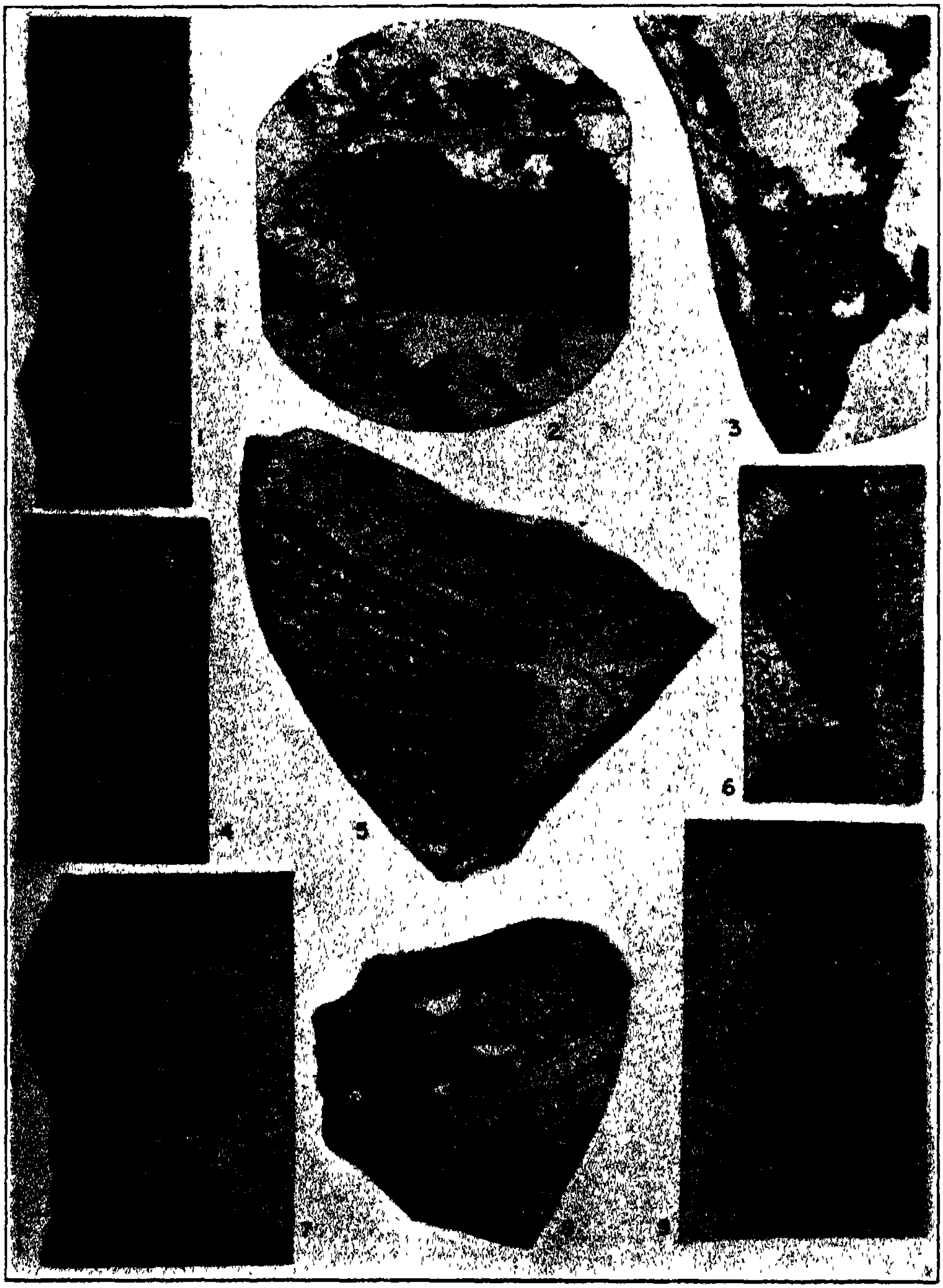
Cyrtocerina modesta Flower, n. sp. Paratype, No. 23970, Upper Whitewater formation, Madison, Indiana. Lateral (2), adapical (6), and dorsal (7) aspects.

Cyrtocerina madisonensis (Miller) lateral (3) and adapical (4) views of hypotype No. 23966. Madison, Indiana.

Wetherbyoceras? cyrtocerinoides Flower, n. sp. (9) vertical section, (10) adoral view, and (11) enlargement of siphuncle showing annulosiphonate deposits, of holotype, No. 23971. Upper Whitewater, Madison, Indiana.

Cyrtocerina madisonensis (Miller). Hypotype, No. 23965. (12) thin section, ×2½; (13), opaque section of the same specimen, ×1; (14), enlargement of dorsal wall of siphuncle from middle part of specimen, about ×18.


1
2
3
4
5
6
7
8
9
10
11
12
13
14


1
2
3
4
5
6

margin of the siphuncle either without bending apicad at all, (Pl. 1, fig. 14, pl. 2, fig. 4, also figs. 1 and 7) or else there is only a vestige of a neck (Pl. 2, fig. 2). The structures which appeared in opaque section to represent accessory deposits, are revealed as curiously thickened connecting rings, rather variable in shape and composition, which are more or less produced into the cavity of the siphuncle. Both the thickness of the rings and the tendency for different regions to show structural variations, are reminiscent of the structures previously reported by the writer (Flower, 1941), as characterizing the older and more generalized of the Eurysophonata.

As structures and forms of the connecting rings vary somewhat from dorsum to venter, the two sides of the siphuncle are best discussed separately. The ventral side of the siphuncle is shown in Pl. 2, fig. 1, and a further enlargement of the apical portion of this figure is illustrated in Pl. 2, fig. 7. Traces of the mural part of the septum can sometimes be made out against the wall of the conch, but it is rarely possible to determine whether it extends forward for the entire length of the camera or not. The free part of the septum is straight, strongly inclined apicad, and terminates without any modification which could be construed as a true neck. The upper of the two septa shown in Pl. 2, fig. 7 is retouched to bring out its outline. The other is unmodified from the original

The connecting rings are more or less semi-oval, the siphonal side convex, while the cameral side is usually straight, though, as seen in the uppermost segment of Pl. 2, fig. 1, it may occasionally be concave. The ring is divisible into two parts. On the siphonal surface one part appears as a thin dark band, sometimes more or less irregularly swollen in places. This contrasts strongly with the broader lighter area on the cameral surface. The condition is superficially similar to that noted in the aneuchoanitic *Proterocameroceras* (Flower, 1941, Pl. 1, figs. 3–5), but closer inspection shows that while zones of similar proportion occur in *Proterocameroceras* the contact between them is sharp. Here it is gradational.

The entire connecting ring contrasts strongly with the septa, the wall of the shell, or infiltrated calcite occupying the cavities of the camerae or siphuncle, in its fine grained texture. Examination of the connecting ring under high power shows that it is made up of very minute granules, probably crystals of calcite. If one traces the fine structure from a light to a dark portion of the ring it will be seen that the opacity of the siphonal surface is due to the presence there of closely packed minute granules, while in the lighter areas the grains are larger. The difference in appearance of the two regions is due to texture, and not to any pigment. The dark siphonal margin is very similar in appearance to the matrix within which the shell was buried, and in portions where the connecting ring is in

---

EXPLANATION OF PLATE II

Cyrtocerina madisonensis, No. 23965. (1) Dorsal wall of siphuncle, septa and shell wall, about ×8, showing variation in form and appearance of connecting ring. (3) Adapical portion of section, showing invasion of matrix from broken apex of siphuncle, and modification of replacement of connecting rings in contact with matrix. ×8. (4) Dorsal wall of siphuncle, ×10, crossed nicols. Note coarse crystaline matrix and fine crystaline granules of connecting rings. Coarse crystals are seen in the second ring from the top only, evidently an alteration phenomenon. (5) Opaque section of same specimen, about ×2½. (6) Adoral dorsal connecting rings, about ×35, showing gradation of size of granules between light and dark areas. (7) Enlargement, about ×26, of dorsal wall of siphuncle, the adapical, portion of fig. 1. The outline of the upper septal neck is retouched. (9) Adoral dorsal siphuncular segments showing different form of segments, and distortion of conch, whereby a neck is apparently developed on the second septum from the top of the figure.

Cyrtocerina modesta Flower, n. sp. Holotype, No. 17170, Upper Whitewater, Madison, Indiana. (2) Adoral segment of dorsal wall of siphuncle showing form of ring, unusually well bent neck, and an abnormal bend in the septum in the upper right side of the photograph, ×22. (8) Vertical section complete, × 2½.

contact with matrix, it is very difficult to determine the boundary between the dark siphonal margin and the fine grained faintly dolomitic lime mud. This is shown, though somewhat obscurely, in Pl. 2, fig. 3, which shows the apical end of the siphuncle of our specimen. The extreme tip is missing, and matrix has entered through the broken end. However, the organic nature of the siphonal lining is shown clearly in more adoral segments, for it is well developed there in regions where matrix never penetrated. Quite probably this shell was buried at a time when some tissue still occupied the siphuncle. Matrix is present in the living chamber and has entered a little way into the siphuncle from either end. The greater part of the cavity of the siphuncle is occupied by calcite which has a sharp contact with the invading mud. This is believed to be one example, of which several others have been noted, of calcite representing the position of tissue present at the time of burial of a cephalopod shell.

The textural modifications of the connecting ring were plainly original, and indicate probably the deposition of the connecting ring as fine calcite granules of crystaline nature. These have been less susceptible to replacement and alteration than have the originally aragonitic shell parts. However, they have suffered some alteration, as can be seen when they are viewed through crossed nicols. Under such conditions (Pl. 2, fig. 4), the majority of the connecting rings are seen to be made up of fine granules, each of which has its own optical orientation so that at one position no two adjacent crystals ordinarily attain extinction. This causes the connecting rings to stand out strikingly against the large and irregular calcite crystals of the septa and of the infiltrated calcite in the shell cavities. However, this figure shows a number of areas in which recrystallization has taken place, notably in the upper two connecting rings, so that the granules are replaced by large irregular crystals. No trace of this phenomenon can be seen in ordinary light however, and the original granular structure seems to hold throughout under such conditions. This can be seen by comparing Pl. 2, fig 4 with the upper four segments shown in greater enlargement in Pl. 1, fig. 14. These phenomena indicate that both zonation and the granular nature of the connecting ring were probably original.

The dorsal side of the siphuncle shows the septa terminating ordinarily with no trace of a neck, but instead of sloping apicad throughout their length, they are essentially straight and transverse. This is shown most clearly in Pl. 1, fig. 14, and Pl. 2, fig. 4. Near the adoral end of the specimen (Pl. 2, fig. 8) an interesting condition is shown in which very short necks appear to be developed by abrupt bending. This part of the shell is slightly distorted, and the connecting rings have been moved out of line, and shoved slightly apicad from their original positions. Possibly the same force has been responsible for the bending of the tips of the septa, for the structure is irregular and far from uniform.

The nearest approach to a neck is shown in the adoral septum of the holotype of *Cyrtocerina modesta* (Pl. 2, fig. 2). Here the neck is faintly recurved. However, this specimen shows an abrupt bend in the septum before the siphuncle is attained, shown in the upper right corner of our photograph, which has been observed nowhere else and is probably due to injury. It is possible that injury may have affected the general organization of the shell enough to produce a slightly greater bending at the tip of the septum as well, so it is not certain that this condition is normal.

The connecting rings on the dorsal side of the siphuncle are more or less triangular in shape. The most typical form is shown in a series taken from the middle of Pl. 1, fig. 12, shown in Pl. 1, fig. 14. The ring is subtriangular, the cameral side straight or faintly concave, the siphonal side strongly produced, and extending farthest into the siphuncle at its adoral end. Farther orad in the siphuncle of the same specimen, (Pl. 2, fig. 9), the rings do not project as far into the siphuncle, and the greatest width is near the middle of the ring rather than at its adoral end.

The comma shaped ring of *C. modesta* (Pl. 2, fig. 2) may be diagnostic of the species, but enough segments have not been seen in which the connecting rings were preserved to make this certain.

The series of segments shown in Pl. 1, fig. 14 show the maximum variation noted in texture and mode of preservation of the rings on the dorsal side of the siphuncle. The upper three figures show the most typical condition. As on the ventral side, the greater bulk of the ring is made up of light, transparent, relatively large granules. The siphonal border consists of a more opaque area, again resembling matrix where it is most completely developed. As before, the two areas intergrade. The cameral surface of the ring shows a similar marginal opaque area. The simplest condition, showing the most gradual change from the central light area to the dark margin, is shown in the second segment from the top of our figure. In this the marginal opaque areas have not attained as great a development as in neighboring segments. The fourth segment from the top shows a curious darkening of a very broad band along the cameral surface. The next few segments are uniformly dark, a condition which is believed to be due to alteration connected in some manner with the invasion of sediments to these segments, as shown in Pl. 2, fig. 3. Rather strangely, segments which occur farther apicad in this series and which are more completely surrounded by matrix, show less modification. The second segment from the bottom of the same figure is unique among the rings observed in *Cyrtocerina* in that its siphonal surface appears to be marked by a thin line which seems to represent a definite wall. This sets off the main mass of the connecting ring from an irregular band of dark material resembling matrix, which in this case it probably is.

Interpretation of the structural significance of the various bands of the connecting ring of *Cyrtocerina* is still uncertain. Evidently the modification was original, for the same phenomena can be recognized, though differently preserved, under different conditions of alteration and replacement. The granular nature of the ring is what one might reasonably expect to be more widely found among fossil nautiloids if, as has been reported of *Nautilus*, their connecting rings are composed of fine crystals of calcite in contrast to the prismatic aragonite of the shell proper. The marginal opaque zones are of uncertain interpretation. Superficially, these bear a strong resemblance to various structures previously observed by the writer in eurysiphonate cephalopods. The eyelet reported in the tip of the connecting ring of several genera, notably among the Tarphyceratidae and in *Vaginoceras oppletum* (Flower, 1941), shows the same very fine grained condition, and the same degree of opacity as do these marginal zones. Similar also is the "inner zone" of the connecting ring on the siphonal surface in *Eurystomites*. Occasionally this and related genera have shown a similar zone on the cameral surface, but it was so faint that I did not at the time regard it as an original structure. Likewise the inner zone of *Proterocameroceras* is similar, though in that genus the zone is clearly set off from the remainder of the deposit, more strongly so than in any other form observed. The irregularity of the opaque material which lies along both the siphonal and cameral surfaces of the deposits, and which can also be seen occasionally against the septa in the camerae, is perplexing largely because of its irregularity. The most logical interpretation seems to be that this may represent vestiges of organic matter derived from tissues present in the camerae and siphuncle at the time of the burial of the conch.

RELATIONSHIP OF CYRTOCERINA

Hyatt (1883) originally placed *Cyrtocerina* with the Holochoanoidea, but later (1900) removed it to the Schistochoanites. That group, now no longer recognized, also contained the genus *Conoceras* Bronn of which Hyatt regarded *Bathmoceras* Barrande as a synonym. *Conoceras* is still very poorly understood, but *Bath-*

moceras appears to be a valid genus in which, as was shown by Holm (1899) processes from the wall of the siphuncle project centrad and orad into the siphuncle. These structures Holm figured as thickened connecting rings. So strong is the resemblance between these rings in *Bathmoceras* and the annulosiphonate deposits of *Polydesmia*, that it appears reasonably certain that *Bathmoceras* is ancestral to the Actinoceroidea. Further examination of this hypothesis showed that if this connection was real, the rings of *Bathmoceras* must be relatively complex. Though no differentiation of structure was shown by Holm, who worked only from opaque sections, it became evident that somewhere in the actinoceroid line there must have occurred a differentiation of the generalized part of the connecting ring and that part which was finally modified to form annulosiphonate deposits. This differentiation was one of material, for even in *Polydesmia* the deposits appear as structures quite distinct from the generalized part of the connecting ring. To eliminate this difficulty, it was suggested that the eyelet was the origin of the greater part of the mass of the deposit of *Bathmoceras*, and that the structure grew orad, finally thickening and sending a lobate process into the cavity of the siphuncle.

The connecting ring of *Cyrtocerina* is not unlike that of *Bathmoceras* in form. On the basis of outline alone the two could be homologized. However, the zonal development of the ring in *Cyrtocerina* is such as to indicate that either the genus must have some other relationship, or else that the structure of *Bathmoceras* is quite different from what Holm's figures and the strong resemblance to *Polydesmia* suggest. Further discrepancies are found in the form of the shells of the two genera, one a slender orthoceracone, the other a short endogastric brevicone. The genera further differ in the condition of the septal neck, *Cyrtocerina* having no true neck developed, while the necks of *Bathmoceras* are long and sometimes show more than a suggestion of cyrtochoanitic structure.

The siphuncle wall of *Cyrtocerina* shows, in the thickness and zoning of the connecting ring, features which the writer has taken as diagnostic of the generalized Eurysiphonata (Flower, 1941). This group, believed to spring from the Plectronoceratidae, is characterized by a thickened connecting ring in which various types of differentiation occur. It was regarded as beginning with the development of the Ellesmeroceratidae, straight or curved conchs with thick rings, and no accessory internal structures. From this group were derived the straight Baltoceratidae and the coiled Tarphyceratidae. The Endoceroidea developed first by the addition of endocones. Later prolongation of the necks produced holochoanitic structure, but the connecting rings are retained at least in the more primitive holochoanitic genera, and still show eurysiphonate characteristics. The rings of all of these groups exhibit two different types of patterns. Where the septal neck is short there is a dense thin inner (siphonal) zone and a lighter (cameral) inner zone. Where the necks are well developed and enclose the connecting ring for a considerable distance, the tip of the ring is differentiated into a mass of dense material, not unlike the inner zone, which was termed the eyelet. Assuming the deposits of *Bathmoceras* were developed from the eyelet, which grew forward over the inner (siphonal) side of the remainder of the connecting ring, it was possible to see in that genus the forerunner of *Polydesmia*, and the origin of the Actinoceroidea in which the inflated eyelet was modified into an annulosiphonate deposit.

While *Cyrtocerina* shows eurysiphonate affinities, it cannot be placed in any of the groups previously noted as members of the Eurysiphonata. On the other hand, it shows some features in common with the Diphragmida, which are very poorly understood at the present time, but the available evidence suggests that they also show eurysiphonate features. Possibly the connection is to be found in the genus *Levisoceras*, now placed in the Diphragmidae by Ulrich and Foerste (1933, 1936), but based upon a species originally placed in *Cyrtocerina*.

Levisoceras Foerste was first proposed because it was believed that *Cyrtocerina mercurius* was holochoanitic, while the genotype of *Cyrtocerina* was regarded as ellipochoanitic. Later Ulrich and Foerste (1933, p. 289), came to the conclusion that instead of being holochoanitic, the septal necks were actually very short, and that the connecting rings were peculiar in structure. Their statements are quoted below:

"However, two occurrences among the Diphragmida suggest that their structure may not have been holochoanoidal but ellipochoanoidal, the latter term having been introduced by Hyatt for siphuncles in which the septal necks are short and must be supplemented by connecting rings in order to produce a continuous siphuncle. For instance, several specimens from the central mineral region of Texas, apparently referable to *Levisoceras*, not only show the transverse tabulae within the siphuncle, but also segments of the siphuncle which are composed of short septal necks and intermediate connecting rings. Both surfaces of the septal necks are sharply defined from the adjacent matrix but those of the connecting rings apparently diffuse rapidly into the latter so that no sharp line exists between the rings and the matrix. Moreover, the substance of the connecting rings is slightly lighter in color than that of the septal necks."

The same forms were those which showed vestigial necks, as shown by the following statement of Ulrich and Foerste from the same paper: "In the Texan Diphragmida here described the septa curve downward only slightly on approaching contact with the siphuncle, this downward curvature being too slight to merit the name *neck*. They certainly are not orthochoanitic and the term aneuchoanitic (without neck) is here proposed for structures of this type."

Cyrtocerina agrees strikingly with *Levisoceras* in form. The genera have been separated on the basis of supposed internal differences From the above quotations it can be seen that the genera agree in the aneuchoanitic necks, and the description of the connecting rings of *Levisoceras* might be equally well applied to those of *Cyrtocerina*. The only remaining difference is that *Levisoceras* is reported as possessing diaphragms which cross the siphuncle.

Cyrtocerina is unique among its contemporaries in the wall of the siphuncle. Its relationship can be best explained as a derivative of *Levisoceras* which has lost the diaphragms. At the present time, it is not possible to point out any other structural difference between the two genera. It is interesting to note in this connection that one section of *Cyrtocerina* which fails to attain the center of the siphuncle, shows apparent diaphragms because the processes of the connecting rings continue unbroken across the siphuncle. This suggests that some, though evidently not all, of the structures which have been described as diaphragms may be derived from connecting rings. This is particularly applicable to the exceedingly vague structures which Kobayashi (1933) has called pseudodiaphragms, in *Multicameroceras* and *Sinoeremoceras*.

REFERENCES

Barrande, J. 1865–77. Système Silurien du centre de la Bohême. Vol. II. Cephalopodes. Prague.

Billings, E. 1865. Paleozoic Fossils, Vol 1, Geol. Surv. Canada, 426 pp., 400 figs.

Clarke, J. M. 1897. The Lower Silurian Cephalopoda of Minnesota. Geol. Minnesota, 3, pt. 2: 761–812, pls. 47–60.

Flower, R. H. 1939. Study of the Pseudorthoceratidae. Paleontographica Americana, Vol. 2, No. 10, 214 pp., 9 pls., 22 figs.

1941. Notes on structure and phylogeny of eurysiphonate cephalopods. Paleontographica Americana, Vol. 3, No. 13, 56 pp., 3 pls., 3 figs.

Foerste, A. F. 1924. Notes on American Paleozoic cephalopods. Denison Univ. Bull., Sci. Lab. Jour., 20: 193–268, pls. 21–42.

1925. Notes on cephalopod genera, chiefly coiled Silurian forms. Denison Univ. Bull., Sci. Lab., Jour., 21: 1–70, pls. 1–24.

1933. Black River and other cephalopods from Minnesota, Wisconsin, Michigan and Ontario, Part II, Denison Univ. Bull., Sci. Lab., Jour., 28: 1–146.

Holm, G. 1899. Om Bathmoceras. Geol. For. Forh. Stockholm, Bd. 21, Haft 4: 271–305, pls. 5–12.

Hyatt, A. 1884. Genera of fossil cephalopods. Boston Soc. Nat. Hist., Jour., 22: 253–338.

1900. Cephalopoda, in Zittel-Eastmann Textbook Paleontology, Vol. 1, 1st ed., London, pp. 536–592.

Kobayashi, T. 1933. Faunal study of the Wanwanian (basal Ord.) series with special note on the Ribeiridae and the Ellesmeroceroids. Tokyo Imp. Univ., Faculty Sci., Jour., Sec. 2, Vol. 3, pt. 7: 249–328, pls. 1–10.

Miller, S. A. 1894 (adv. sheets 1892). Paleontology. 18th Ann. Rep. Indiana Dept. Geol. Nat. Res., pp. 257–356, pls. 1–12.

Miller, S. A., and Faber, C. 1894. New species of fossils from the Hudson River group and remarks upon others. Cincinnati Soc. Nat. Hist., Jour., 17: 22–23, pl. 1.

Ruedemann, R. 1906. Cephalopods of the Champlain Basin. New York State Museum, Bull. 90, 611 pp., 38 pls., 57 figs.

Ulrich, E. O., and Foerste, A. 1933. The earliest known cephalopods. Science, n. s., 78: 288–289.

On Growth and Form

This voluminous book is an enlarged and revised edition of the book of the same title published twenty-five years ago. The problems of growth and form are discussed purely from the standpoint of mathematics and physics. In the words of the author his "sole purpose is to correlate with mathematical statement and physical law certain of the simpler outward phenomena of organic growth and structure or form, while all the while regarding the fabric of the organism as a material and physical configuration." The following paragraph contains samples of topics discussed and conclusions reached.

The total resultant force which the bird employs for its support varies empirically as the square of the air speed. Man is ruled by gravitation, whereas the surface of a pool is a matter of life and death to a water beetle. In the world where the bacillus lives gravitation is forgotten, whereas the viscosity of the liquid, molecular shocks of the Brownian movement and electrical charges of the ionized medium are all of great importance. The form of an organism is determined by its rate of growth in various directions and is an "event in space-time." The cell is a sphere of action of localised forces, of which surface tension is the most important in giving the cell its shape and individuality. The actual conformation of the cell usually is the complex resultant of surface tension, acting together with gravity, mechanical pressure, osmosis and other physical forces. The unique beauty of a soap bubble depends upon the absence of such forces from the field, the resulting form is in such a case so simple that we come to regard it as almost a mathematical abstraction. The various morphological characteristics of the tiny polyp have their parellels in the surface tension phenomena of the splash. The figure produced by using a hanging drop, which while it sinks remains suspended to the surface is analagous to that of a medusa or jellyfish, with its umbrella and manubrium. Flagella, cilia, chitinous hairs, etc., tend to occur where the surface tension would be least, were the surface fluid. Cell membrane and cell wall formation is the result of adsorption. In tissues or cell aggregates surface tension manifests itself in the minimum area which the circumstances of the case permit. Thus in a mass of soap bubbles enclosed in a narrow vessel with flat sides of glass, in a plane section of vegetable parenchyma, and on the surface of a honeycomb the cell walls meet by threes, at angles of 120°, forming hexagonal cells. This arrangement mathematically and physically, provides minimal surface. The efficient architecture of the bee cell is due to mechanical forces rather than to any planned economy on the part of the bee. The Nautilus, snail shell and Globigerna grow as equiangular spirals, rather than as the spiral of Archimedes. Shell forms which are mathematically identical are found in all geological periods, regardless of climate and on shores and in ocean depths. The quadriped skeleton has two balanced cantilevers, one supported on the fore-legs and the other on the hand. The skeletal construction of the bird is more complex, part of the time the whole weight is borne by the legs, and part of the time by the wings. Coordinate geometry may be of considerable value in illustrating differences between related forms.

The various subjects are treated along strictly physical and mathematical lines. Thus heredity and various physiological phenomena are not considered. Geometric and physical principles are discussed at length. Growth is considered in relation to magnitude, "as a phenomenon at the end of a morphological rather than at the beginning of a physical inquiry." While not offering solutions to any major biological problems, this book is a prolific source of unique and interesting material. The reader will likely learn more geometry and physics than biology.—*D. C. Rife.*

Growth and Form, by D'Arcy W. Thompson. xvii+1116 pp., 554 illus. MacMillan Co., New York, 1942. $12.50.

PHOTOPERIODIC AFTEREFFECTS IN IPOMOEA[1]

VICTOR A. GREULACH
University of Houston, Houston, Texas

Photoperiodic aftereffects[2] were first observed by Garner and Allard (8) in 1923, and have been studied since then in about two dozen species of plants. Due largely to the extensive studies of Borthwick and Parker (2, 3, 4, 17, 18), we now know more about photoperiodic aftereffects in Biloxi Soy Beans than in any other plant. Photoperiodic aftereffects in soy beans have also been studied by Garner and Allard (8), Eghiz (7), Murneek (15), and others. Considerable work on aftereffect in millet has been done by various Russian botanists (5, 6, 14, 23). Photoperiodic aftereffects in chrysanthemum have been studied by Poesch (19), Post (20, 21), and Link (13), in ***Xanthium*** by Hamner and Bonner (10) and Neidle (16), in dill by Hamner and Naylor (12), and in Klondike Cosmos by Biddulph (1). Other species which have been studied less thoroughly include teosinte, oats, barley, common cosmos, radish, poinsettia, rice, cotton, ***Rudbeckia*** and spinach. These studies have dealt primarily with reproductive aftereffects, but aftereffects involving tuber formation have been reported in ***Solanum*** by Razumov (24) and Pushkarev (22) and in ***Helianthus tuberosus*** by Hamner and Long (11).

In view of the fact that none of these plants has been a vine and that none has belonged to the ***Convolvulaceae*** the writer considered it worth while to investigate possible photoperiodic aftereffects in ***Ipomoea***. The species employed were the Japanese morning glory (***I. hederacea*** Jacq.) and the common morning glory (***I. purpurea*** Roth.). Both of these species were classified by Garner and Allard (8) as short day plants, although Roberts and Struckmeyer (25) found that the latter species would also bloom under long photoperiods if the temperature was relatively low.

EXPERIMENTAL METHODS

A transfer technique similar to that employed in previous investigations on photoperiodic aftereffects was used. Plants of both species were subjected to from 1 to as many as 20 induction photoperiods of 9 hours each, transfers to long photoperiods being made daily. In the various experiments plants were kept under long photoperiods for different lengths of time before being subjected to the induction treatments, thus securing plants of different ages at the time the treatments were begun. Care was exercised that plants would be subjected to short photoperiods only during the allotted induction periods. Control plants were kept under short photoperiods from the beginning of the treatments to the end of the experiments. Other control plants were retained under long photoperiods throughout the experiments.

The experiments were conducted at Columbus, Ohio, between April 22 and September 3, 1939. The photoperiods designated as long were between 15 and 16¼ hours in length. These were obtained by using the natural photoperiods, either alone or supplemented with light from Mazda bulbs; these providing a minimum of 3 foot candles of light, although most of the plants received at least 20 foot candles of light. The photoperiods designated as short were 9 hours in length, and were obtained by means of light-proof, ventilated chambers and cabinets. The temperature differences between the inside and outside of these were not great enough to have any significant effect on the development of the plants. The minimum temperature to which any of the plants was exposed was 56° F., and for short periods only. The mean temperatures ranged between 70° F. and 80° F.

---

[1] Papers from the Department of Botany, The Ohio State University, No. 438.

[2] Although the terms ***photoperiodic induction*** and ***photoperiodic aftereffect*** are often used synonymously the writer believes that they logically refer to distinct phenomena. As used here the term ***photoperiodic induction*** is restricted to the initiation of sexual reproduction in plants under the influence of the photoperiod. The term ***photoperiodic aftereffect*** is applied to the continuation of reproductive development after photoperiods favoring its initiation have been replaced with photoperiods unfavorable or less favorable for induction. The term may also be applied to the continuation of vegetative development characteristic under certain photoperiods after these have been replaced by others under which such development would not initially occur. A detailed discussion of this terminology is given elsewhere (9).

The plants were maintained in five-inch porous clay pots according to good greenhouse practice, and care was taken to keep such factors as soil, moisture and light intensity as uniform as possible.

TABLE I

DATA ON THE ORGANIZATION OF THE EXPERIMENTS

SPECIES	EXPT. No.	DATE PLANTED	NUMBER OF DAYS FROM PLANTING SEEDS TO THE:			PLANTS PER TREATMENT
			Beginning of Treatments	Time of the Last Transfer	End of the Experiment	
I. hederacea. (yellow-green)	I	April 21	40	60	96	2
" "	II	June 13	4	21	62	3
I. hederacea.. (dark green)	III	June 29	5	18	66	4
" "	IVa	June 29	28	38	66	4
" "	IVb	June 29	28	41	66	3
I. purpurea...	I	April 21	40	60	96	3
" "	II	June 13	4	22	66	4
" "	III	June 29	5	22	66	3
" "	IV	June 29	28	45	66	3

Eight different experiments were conducted, four on each species. In the first two experiments on *I. hederacea* a strain with pale yellow-green foliage was used, while in the last two a strain with dark green pigmentation, similar to that of *I. purpurea*, was employed.

In Experiment IV on *I. hederacea* the plants were divided into two series, *a* and *b*. The plants in Series *a* were treated in the usual way, but the plants in Series *b* had only one leaf each exposed to nine hour photoperiods. This was accomplished by means of light-proof black cloth bags placed in position and removed daily.

Daily records were made of the development of the plants, including a complete record of anthesis, and at the close of each experiment the height of each plant was measured and the number of fruits on each was counted. All plants which had not bloomed were carefully examined for flower buds with a low power binocular microscope. Specific details about the organization of the experiments are given in Table I.

RESULTS AND DISCUSSION

Detailed data on each of the experiments are too extensive to present here but are available elsewhere (9). It will suffice here to describe and discuss the more important results, considering in turn the aftereffects related to flower bud formation, anthesis, and fruit formation.

Flower buds developed on at least some of the plants in all the treatment groups in the experiments on *I. hederacea* (Table II), and in the first three experiments flower buds were also present on the control plants, which were retained under photoperiods 15 hours or more in length throughout the experiments. However, the influence of the short day treatments was clearly evident, as the buds on the control plants appeared much later than on the treated plants, and in no case before the plants were 46 days old. None of the *I. purpurea* plants exposed to less than 2 short photoperiods formed flower buds, and in Experiments II and III on this species flower buds appeared only on plants exposed to 7 or more and 11 or more short photoperiods respectively. Since treatments were begun in these experiments 4 and 5 days respectively after planting, and were not begun until 40 and 28 days after planting in the other two experiments, it appears that induction treatments may be more effective in inducing flower bud formation when applied to older plants. The formation of flower buds on the control plants of *I. hederacea* indicates that this is less strictly a short day species than *I. purpurea*.

TABLE II

MINIMUM NUMBERS OF SHORT PHOTOPERIODS WHICH INDUCED VARIOUS AFTEREFFECTS

EXPERIMENT	MINIMUM NUMBERS OF SHORT PHOTOPERIODS WHICH INDUCED					
	Flower Buds	Terminal Flower Buds	Anthesis	First Anthesis	Last Initial Anthesis	Fruit Formation
Ipomoea hederacea I	0	2	0	12	0	0
" " II	0	2	2	11	2	2
" " III	0	5	5	13	5	5
" " IVa	1	7	3	7	3	6
" " IVb	1	11	4	9	4	13
Ipomoea purpurea I	2	8	3	4	3	4
" " II	7	13	7	10, 11, 14, 16, 17	12	13
" " III	11	12	11	7	11, 12	12
" " IV	2	17	8	14, 15	9	17

More short photoperiods were necessary for the induction of terminal flower buds than lateral flower buds (Table II). The yellow-green plants of *I. hederacea* were most sensitive in this respect, terminal flower buds developing on some of the plants exposed to 2 to 4 short photoperiods, and on all the plants exposed to 5 or more short photoperiods. Terminal flower bud formation was much less extensive in the dark green plants of this species, being present only in scattered plants exposed to 5 or more short photoperiods. A terminal flower bud formed on only one of the plants subjected to localized induction photoperiods, it having been exposed to 11 short photoperiods.

In *I. purpurea* terminal flower buds were also rare, and except in the first experiment occurred only on scattered plants exposed to 12 or more short photoperiods. In the first experiment terminal flower buds formed on one plant each in the groups exposed to 8, 9, 10, and 14 short photoperiods and on all plants exposed to 15 or more short photoperiods. The greater abundance of terminal flower buds on these plants was probably due in part to the greater age of the plants at the time the treatments were begun, and in part to the fact that this experiment was continued a month longer than the other experiments on *I. purpurea*. Terminal flower buds formed on all plants of both species which were retained under short photoperiods from the beginning of the treatments to the ends of the experiments. Most of the terminal flower buds developed into flowers, but a few on the plants subjected to the lesser number of short photoperiods failed to develop further.

A very striking result of the formation of terminal flower buds was a cessation of growth of the main axis and the consequent dwarfing of the plants (Fig. 1). In some of the plants exposed to fewer numbers of short photoperiods branches continued to grow and one exhibited apical dominance. The resulting plant as a whole had the usual viny form, but in most of the plants terminal flower buds soon formed on the branches, resulting in a bushy plant entirely unlike the usual morning glory plant. It is possible that non-viny *Convolvulaceae*, such as *Convolvulus tricolor*, are bushy because their terminal flower buds develop under longer photoperiods than in other members of the family.

The average height of the dwarfed plants was 30 cm. for the plants treated beginning 4 or 5 days after planting and 118 cm. for those treated when older. The yellow-green plants of *I. hederacea* averaged the shortest, followed in order by the dark green plants of this species and the *I. purpurea* plants. In all but one experiment (*I. purpurea*, Expt. III) the plants retained under short photoperiods were shorter on the average than the plants returned to long photoperiods after induction, apparently because of the continued influence of the short photoperiods. No explanation for the exception is evident. However, formation of terminal flower buds did not necessarily occur earlier with an increase in the number of induction photoperiods, many plants exposed to the larger numbers of short photoperiods having main stems averaging about the same in height as those on which terminal flower buds developed after exposure to as few as 2 short photoperiods. The shortest main stems were those of two plants of *I. hederacea* in Experiment I which had been exposed to 15 and 16 short days and were only 8 cm. tall.

In general, extensive branching accompanied the formation of terminal flower buds, probably as a result of the loss of apical dominance, and branching was rare in plants with terminal vegetative buds. For example, in Experiment I on *I. hederacea* 78 per cent of the plants had terminal flower buds and 71 per cent had branches, while in Experiment III on this species only 8 per cent had terminal flower buds and none had branches. When plants with terminal flower buds failed to branch, as was evident particularly in Experiment II on *I. hederacea*, in which 78 per cent of the plants had terminal flower buds but only eight per cent had branches, it was evidently because all the axillary buds had developed into flower buds so that no further stem elongation was possible.

In Experiment I on *I. hederacea* the control plants kept under long photoperiods began blooming 85 days after planting. None of the control plants in the other experiments bloomed, although some of the *I. hederacea* controls which had flower buds might have bloomed had the experiments been continued longer. In these experiments the minimum number of short photoperiods necessary to induce anthesis ranged from 2 to 5, and in *I purpurea* from 3 to 11 (Table II). Using this as a criterion *I. hederacea* may be considered as more sensitive to photoperiodic induction than *I. purpurea*, and the yellow-green strain of the former species as more sensitive than the dark green strain.

Aftereffects were much more pronounced in the yellow-green plants of *I. hederacea* than in the dark green plants of either species insofar as abundance of bloom is concerned, and flowers were more abundant on the dark green plants of *I. hederacea* than on the *I. purpurea* plants. There was a general tendency for the plants exposed to greater numbers of short photoperiods to bloom more abundantly than those exposed to smaller numbers, but there was no regular increase in abundance of bloom with an increase in the number of induction photoperiods. All plants retained under short photoperiods bloomed much more abundantly than those returned to long photoperiods. There was no distinct correlation between either the abundance of bloom or the minimum number of short photoperiods necessary to induce anthesis and the age of the plants at the time the treatments were begun.

Fig. 1. Representative plants of *Ipomoea hederacea*, Experiment II, showing the dwarfing which resulted from the conversion of the terminal bud to the determinate reproductive condition. The figures give the number of short photoperiods to which the plants were exposed. The plant labeled "C" was retained under long photoperiods throughout the experiment. Photographed July 31, 1939.

In *I. hederacea* anthesis first occurred in plants exposed to a fairly large number of short photoperiods, and the last plants to begin blooming were ones exposed to only a few short photoperiods, but this was not true of *I. purpurea* (Table II). Anthesis first began in the plants retained under short photoperiods from the beginning of the treatments at about the same time as in the plants returned to long photoperiods (Table III). Both the time of initial anthesis and the beginning of the period of maximum anthesis correlated with the number of days from the beginning of the treatments rather than with the number of days from planting (Table III). The time from the beginning of the treatments to the first anthesis varied from 21 to 30 days and the time to the beginning of maximum anthesis varied from 25 to 30 days. That the treatments were somewhat more effective on plants which were older at the beginning of the treatments is indicated by the fact that the average time from the beginning of the treatments to initial anthesis was 24 days for the older plants and 29 days for the younger plants. The average time to the beginning of maximum anthesis was 28 and 30 days respectively. There was little difference between the two species or between the yellow-green and dark green plants in the time required for initial and maximum anthesis to begin.

The number of short photoperiods necessary for the induction of fruit formation was about the same as that for the initiation of terminal flower buds (Table II), and except in the first three experiments on *I. hederacea* was greater than the number required for inducing anthesis. Fewer numbers of short photoperiods were necessary in both strains of *I. hederacea* than in *I. purpurea*, except in the plants of which single leaves were exposed to localized short photoperiods. The percentage of the test plants bearing fruits was markedly higher in *I. hederacea* than in the comparable experiments on *I. purpurea*, except in Experiment I on each species, where the longer duration of the experiments may have made some equalization possible, and in the plants given localized short photoperiods, only 5 per cent of which formed fruits. In Experiment I, fruits developed on 73 per cent of the *I. hederacea* plants and on 61 per cent of the *I. purpurea* plants. In Experiments 2, 3, and 4 the percentages were 61 and 13, 24, and 7, and 40 and 2 for *I. hederacea* and *I. purpurea* respectively. Fruits developed on 77 per cent of the plants retained under short photoperiods. The percentage of flowers developing into fruits was extremely variable from treatment to treatment and there was no correlation with the number of short photoperiods or the species, but it was higher in the plants retained under short photoperiods than those returned to long photoperiods.

Photoperiodic aftereffects were evident in the plants of *I. hederacea* which had only one leaf each exposed to short photoperiods (Exp. IV b), but these were much less extensive than in comparable plants exposed in their entirety to short photoperiods (Exp. IV a). Flower buds formed on a plant exposed to only one localized short photoperiod, anthesis occurred on plants exposed to 4 or more localized short photoperiods except in the groups exposed to 5 and 10 short photoperiods, and fruits formed on one plant exposed to 13 localized short photoperiods. A terminal flower bud developed on one plant exposed to 11 localized short photoperiods when it was 101 cm. high.

The various tabulations fail to indicate adequately the rather marked differences in development among plants receiving identical treatments. These differences of reaction to the photoperiod were in many cases too marked to be due to other slight differences in environment and it appears that individual hereditary differences in reaction to the photoperiod are greater within ordinary unselected species than is generally recognized.

The more pronounced photoperiodic aftereffects of the yellow-green strain of *I. hederacea* than of the dark green strain may have been due either to genetic linkage of the factors affecting sensitivity to the photoperiod and the factors affecting pigment formation, or to a more or less direct physiological connection between pigmentation and sensitivity to the photoperiod. The latter appears possible since Murneek (15) found that in several short day plants the carotene and xanthophyll content was higher in plants growing under short photoperiods than those growing under long photoperiods.

A quantitative and cumulative relationship between exposure to short photoperiods and photoperiodic aftereffects was indicated by the following results: a general increase in photoperiodic aftereffects with an increase in the number of short photoperiods to which the plants were exposed; more extensive reproductive development in plants retained under short photoperiods than in those returned to long photoperiods; and the lesser aftereffects in *I. hederacea* plants exposed to localized short photoperiods than in comparable plants exposed in their entirety to short photoperiods These results are in accord with the florigen theory.

TABLE III

LENGTHS OF TIME FROM PLANTING AND BEGINNING OF TREATMENTS TO THE INITIATION OF ANTHESIS

EXPERIMENT	NUMBER OF DAYS FROM PLANTING TO:				NUMBER OF DAYS FROM BEGINNING OF TREATMENTS TO	
	Beginning of Treatments	First Anthesis of		Period of Maximum Anthesis	First Anthesis	Beginning of Maximum Anthesis
		Test Plants	Short Day Plants			
Ipomoea hederacea I	40	64		70-80	24	30
" " II	4	31		35-41	27	31
" " III	5	35	36	36-43	30	31
" " IVa	28	54	52	56-66	26	28
" " IVb	28	56	52	56-66	28	28
Ipomoea purpurea I	40	61		65-80	21	25
" " II	4	34	35	34-40 58-62	30	30
" " III	5	33	36	34-37	28	29
" " IV	28	51	51	55-62	23	28

SUMMARY

Plants of *Ipomoea hederacea* and *I. purpurea* exhibited photoperiodic aftereffects in various degrees when transferred to long photoperiods after having been exposed to various numbers of 9 hour photoperiods. In general, more short photoperiods were necessary to induce anthesis than flower bud formation, and still more to induce fruit formation. The photoperiodic aftereffects were generally more pronounced with an increase in the number of short photoperiods to which the plants were exposed and with an increase in the age of the plants at the time the treatments were begun, but reproductive development was not as extensive in the transfer plants as in those retained under short photoperiods from the beginning of the treatments to the end of the experiments.

A pale yellow-green strain of *I. hederacea* exhibited more marked photoperiodic aftereffects than plants of the dark green strain of this species, and the aftereffects in *I. purpurea* were less marked than in either strain of *I. hederacea.*

Except in one experiment, flower buds developed on plants of *I. hederacea* retained under long photoperiods, indicating that this species is not strictly a short day plant, although the added influence of the short day treatments was clearly evident. In *I. purpurea* flower buds developed only on plants exposed to 2 or more short photoperiods.

Terminal flower bud formation occurred only after exposure to minima of from 2 to 7 short photoperiods in *I. hederacea* and 8 to 17 short photoperiods in *I. purpurea*, and was much more frequent in the former. This resulted in the formation of dwarf plants, many of which were bushy and some of which had main stems as short as 8 cm. The plants on which experiments were begun when they were very young were shorter than those on which treatments were begun later. Branching was in general more extensive on the plants with terminal flower buds, but some of these did not branch because all lateral buds had developed into flower buds.

The minimum number of short photoperiods which induced anthesis in *I. purpurea* was 3 and the minimum in *I. hederacea* was 2, except that in one experiment on the yellow-green strain of the latter species even the plants retained under long photoperiods bloomed. Anthesis began in from 21 to 30 days after the beginning of the treatments. Initial anthesis occurred about the same time in some of the transfer plants as in those retained under short photoperiods. The number of short photoperiods necessary for induction of fruit formation was about the same as that for the initiation of terminal flower buds.

Plants of the dark green strain of *I. hederacea* exhibited photoperiodic aftereffects after the application of localized short photoperiods to one leaf, but these aftereffects were much less marked than those in comparable plants exposed in their entirety to short photoperiods.

The writer wishes to acknowledge his indebtedness to Dr. B. S. Meyer of the Ohio State University for helpful suggestions during the progress of this investigation and for criticisms of the manuscript.

LITERATURE CITED

(1) **Biddulph, O.** 1935. Histological variations in cosmos in relation to photoperiodism. Bot. Gaz., 97: 139–155.

(2) **Borthwick, H. A.,** and **Parker, M. W.** 1938. Influence of photoperiods upon the differentiation of meristems and the blossoming of Biloxi soy beans. Bot. Gaz., 99: 825–839.

(3) 1938. Effectiveness of photoperiodic treatment of plants of different age. Bot. Gaz., 100: 245–249.

(4) 1938. Photoperiodic perception in Biloxi soy beans. Bot. Gaz., 100: 374–387.

(5) **Chailakhian, M. K.,** and **Aleksandrovskaia, V. A.** 1935. Nature of the photoperiodic after effect (induction) and effect of the day length on the activity of the oxidising enzymes. Compt. Rend. Acad. Sci. URSS., 2: 161–166.

(6) **Dolgushin, D. A.** 1932. On the problem of the photoperiodic aftereffect. Bull. Jaroviz., 1: 30–35.

(7) **Eghiz, S. A.** 1928. Contribution to the question of photoperiodism with soy beans and corn. Mem. Inst. Agron. Leningrad, 5: 5–32.

(8) **Garner, W. W.,** and **Allard, H. A.** 1923. Further studies in photoperiodism, the response of the plant to relative length of day and night. Jour. Agr. Res., 23: 871–920.

(9) **Greulach, V. A.** 1940. Macroscopic photoperiodic aftereffects in various species of plants. Doctor's Dissertation, The Ohio State University.

(10) **Hamner, K. C.,** and **Bonner, J.** 1938. Photoperiodism in relation to hormones as factors in floral initiation and development. Bot. Gaz., 100: 388–431.

(11) ——, and **Long, F.** 1939. Localization of photoperiodic perception in *Helianthus tuberosus.* Bot. Gaz., 101: 81–90.

(12) ——, and **Naylor, A. W.** 1939. Photoperiodic responses of dill, a very sensitive long day plant. Bot. Gaz., 100: 853–861.

(13) **Link, C.** 1936 (1937). Preliminary studies on flower bud differentiation in relation to photoperiodic response. Proc. Amer. Soc. Hort. Sci., 34: 621–623.

(14) **Maximov, N. A., Doroshenko, A. V.,** and **Razumov, V. I.** 1928. Photoperiodism in cultivated plants. Dnevnik Vsesoiuznogo Siezda Botanikov, Leningrad. 1928: 294–295.

(15) **Murneek, A. E.** 1937. Biochemical studies of photoperiodism in plants. Univ. Mo. Agr. Res. Bull., 268.

(16) **Neidle, E. K.** 1939. Nitrogen nutrition in relation to photoperiodism in *Xanthium pennsylvanicum*. Bot. Gaz., 100: 607–618.

(17) **Parker, M. W.,** and **Borthwick, H. A.** 1939. Effect of the photoperiod on the development and metabolism of the Biloxi soy bean. Bot. Gaz., 100: 651–689.

(18) 1939. Effect of variation in temperature during photoperiodic induction upon initiation of flower primordia in Biloxi soy bean. Bot. Gaz., 101:145–167.

(19) **Poesch, G. H.** 1932 (1933). Further studies of photoperiodism of the chrysanthemum. Proc. Amer. Soc. Hort. Sci., 29: 540–543.

(20) **Post, K.** 1932 (1933). Further results with black cloth for the production of early blooms of the chrysanthemum. Proc. Amer. Soc. Hort. Sci., 29: 545–548.

(21) 1934. Production of early blooms of chrysanthemums by use of black cloth to reduce the length of day. Cornell Agr. Expt. Sta. Bull. 594.

(22) **Pushkarev, I. I.** 1933. The effect of a shortened day during green sprouting of seed tubers on development and yield of potatoes. Trans. All Union Potato Sci. Res. Inst., 1: 90–105.

(23) **Rasumov, V. J.** 1930. On the photoperiodical aftereffect in connection with the influence on crops of the different time of sowing. Bull. App. Bot. Genet. and Plant Breed., 23: 61–109.

(24) 1931. Influence of alternate day length on tuber formation. Bull. App. Bot. Genet. and Plant Breed., 27: 3–46.

(25) **Roberts, R. H.,** and **Struckmeyer, B. E.** 1938. Photoperiod, temperature and some hereditary responses of plants. Jour. Hered., 29: 95–98.

Human Heredity in Picture Form

In this book the author has presented the thesis that many common normal traits run in families and make fascinating material for studies in human heredity. Photographs and descriptions are offered of about 200 such traits. For those who have gotten the impression that only the abnormalities stressed by many authors are genetic, the book brings a refreshing viewpoint on normal and benign variations. For the serious student of genetics, however, the book is disappointing. References to literature are poorly chosen. Older literature is often cited and modern interpretations ignored. Many of the subjects discussed have no citations at all, although good papers exist.

The phylogenetic relations of genes are badly mishandled. This reviewer has on numerous occasions pointed out the lack of understanding of matters of genotype equilibrium on the part of writers on human heredity. The author of this book says, for example, (p. 109) "Since about 65 per cent of individuals can roll the tongue, this trait may be a dominant one."

Psychologists will find much to disagree with in the book, particularly in the chapter on temperaments and special abilities. Even the most genetically-minded psychologist (or biologist) will find it difficult to accept a genetic basis for such a trait as good taste in dress.

A chapter is included on sex and sex-determination, and a glossary of 91 terms and an index complete the book.—*L. H. Snyder.*

Family Treasurers, by David D. Whitney. 299 pp., 234 fig. Lancaster, Penna., the Jaques Cattell Press, 1942. $3.50.

THIRD ANNOTATED LIST OF PHYMATA PREY RECORDS (PHYMATIDAE, HEMIPTERA)

W. V. BALDUF[1]
University of Illinois

During the three years 1938, 1939 and 1940 I made a study of the prey utilized by our common ambush bug, *Phymata pennsylvanica americana* Melin in the vicinity of Urbana, Illinois. The method employed was direct search for the predator as it occupied flowers, mostly wild, growing along roads, ditches and pastures. When Phymatas were discovered possessing prey, the latter was taken from their grasp and placed in a vial with notes identifying the ambush plant and stating whether the preying bug was single, and if so its sex, or coupled or mating, or in some other combination to be described below. Throughout the project I included prey specimens found dead under circumstances that left no reasonable doubt that they had been killed and discarded by *Phymata*. These, however, represent less than 10 per cent of the total. Excepting a few from fifth instar nymphs, all the prey recorded during the study pertained to adult bugs.

The present report, which is intended as the last of this series, embraces the records for 1940. The annotated lists for the preceding two years have already been published (Balduf, 1939, 1940).

TABLE I

INSECT PREY OF *Phymata*, 1940

Systematic Position of Prey Taken			Specimens Captured	Inclusive Dates
Genus	Species	Family		
	COLEOPTERA			
Diabrotica	*12-punctata* (Fabr.)	Chrysomelidae	10	VII-17: X-5
Diabrotica	*longicornis* Say	Chrysomelidae	1	IX-6
	HYMENOPTERA			
Amblyteles	*brevicinctor* (Say)	Ichneumonidae	1	VII-17
Porizon	sp.	Ichneumonidae	1	VII-19
Microbracon	*tenuiceps* Mues	Braconidae	1	VII-19
Bassus	*annulipes* (Cr.)	Braconidae	2	IX-2
Urisigalphus	*femoratus* Cwfd	Braconidae	2	IX-7: IX-9
Apanteles	*forbesi* Vier	Braconidae	1	IX-19
....	....	Pteromalidae	1	IX-19
Apis	*mellifica* Linn	Apidae	8	IX-4: X-5
Bombus	*impatiens* Cress	Bombidae	1	IX-11
Agapostemon	*radiatus* (Say)	Andrenidae	2	VIII-9: IX-16
Calliopsis	*andreniformis* Sm	Andrenidae	6	VII-25: X-21
Andrena	*nubecula* Sm	Andrenidae	1	IX-4
Halictus	*provancheri* D. T	Halictidae	8	VII-17: IX-28
Halictus	*stultus* Cress	Halictidae	4	VII-19: XI-2
Halictus	*coriaceus* Sm	Halictidae	1	VII-25
Halictus	*pruinosus* Robt	Halictidae	1	VII-25
Halictus	*ligatus* Say	Halictidae	1	VII-25
Halictus	*albipennis* Robt	Halictidae	1	VIII-9

---

[1] Contribution No. 228 from the Entomological Laboratories of the University of Illinois. I am again indebted to Mr. C. F. W. Muesebeck and several of his scientific staff in the United States National Museum for determining the prey insects reported here.

TABLE I—(Continued)

SYSTEMATIC POSITION OF PREY TAKEN			SPECIMENS CAPTURED	INCLUSIVE DATES
Genus	Species	Family		
	HYMENOPTERA (Continued)			
Halictus	*versatus* Robt	Halictidae	17	IX-6: X-28
Halictus	spp	Halictidae	8	IX-19. X-28
Augochlorella	*striata* (Prov.)	Halictidae	1	IX-28
Paralictus	*platyparius* Robt	Halictidae	1	X-5
Coelioxys	*octodentata* Say	Megachilidae	1	VII-26
Hylaeus	*stevensi* Cwfd.	Hylaeidae	1	IX-14
Epeolus	*bifasciatus* Cress	Nomadidae	1	IX-3
Philanthus	*ventilabris* Fabr.	Sphecidae	1	VII-17
Sphex	*placidus* (Sm.)	Sphecidae	5	VII-20: VII-25
Larropsis	*distincta* (Sm.)	Sphecidae	1	IX-7
Crabro	sp	Sphecidae	1	IX-26
Psen	*cressoni* (Pack.)	Sphecidae	1	IX-28
Cerceris	*finitima* Cress	Sphecidae	1	VII-20
Cerceris	*clypeata* Cress	Sphecidae	1	VII-25
Cerceris	sp	Sphecidae	1	IX-14
Neoformica	sp	Formicidae	6	VII-17. VII-25
Formica	*pallidefulva nitidiventris* Em	Formicidae	1	IX-11
Formica	*pallidefulva schaufussi incerta* Em	Formicidae	1	IX-26
	LEPIDOPTERA			
Ascia	*rapae* (L.)	Pieridae	2	VII-25: IX-28
Colias	*philodice philodice* Godt.	Pieridae	2	IX-11: IX-13
Colias	*eurytheme* Bdv.	Pieridae	8	IX-28: X-28
Everes	*comyntas comyntas* Godt.	Lycaenidae	3	VII-25: IX-12
Polites	*themistocles* (Latr.)	Hesperiidae	1	IX-12
Pyrgus	*communis communis* (Gr.)	Hesperiidae	2	IX-12: IX-21
Schinia	*acigera* Gn	Phalaenidae	1	IX-19
Rhodophora	*gaurae* (A. & S.)	Phalaenidae	1	VIII-8
Tarachidia	*candefacta* Hbn ?	Phalaenidae	1	IX-7
Prodenia	*ornithogalli* Gn.	Phalaenidae	1	X-5
Feltia	*subgothica* (Haw.)	Phalaenidae	24	IX-7: X-5
Caenurgina	*erechtea* (Cram.)	Phalaenidae	2	IX-12
Crambus	*albellus* Clem?	Crambidae	1	IX-16
Scythris	sp.	Schthridae	1	XI-2
	DIPTERA			
Eugnoriste	*brevirostris* Coq	Mycetophilidae	1	VII-17
Sciara	sp.	Mycetophilidae	5	IX-21: IX-28
Aedes	*vexans* (Mg.)	Culicidae	3	IX-16: IX-26
Culex	*tarsalis* Coq	Culicidae	1	IX-26
Empis	*clausa* Coq	Empididae	8	IX-14: IX-19
Occemyia	sp	Conopidae	4	IX-19: X-28
Sparnipolius	*fulvus* (Wied.)	Bombyliidae	15	IX-11: IX-28
Madiza	sp	Chloropidae	1	IX-6
Hippelates	sp	Chloropidae	1	IX-26
Hylemya	sp	Anthomyidae	12	VII-20: IX-28
Sarcophaga	*tenuiventris* V. d. W	Sarcophagidae	1	IX-11
Sarcophaga	*salva* Aldr.	Sarcophagidae	1	IX-12
Sarcophaga	*sinuata* Mg.	Sarcophagidae	1	IX-28
Sarcophaga	*lherminieri* R. D	Sarcophagidae	2	IX-19: IX-28
Sarcophaga	sp.	Sarcophagidae	1	IX-19
Senotainia	sp.	Sarcophagidae	1	IX-28
Pollenia	*rudis* (Mg.)	Calliphoridae	1	IX-4

TABLE I—(Continued)

Systematic Position of Prey Taken			Specimens Captured	Inclusive Dates
Genus	Species	Family		
	Diptera—(Continued)			
Cochliomyia	*macellaria* (F.)	Calliphoridae	2	IX-7: IX-28
Lucilia	*illustris* (Mg.)	Calliphoridae	1	IX-19
Stomoxys	*calcitrans* (L.)	Muscidae	1	IX-16
	spp	Tachinidae	4	IX-2
Chaetogaedia	*monticola* Big	Tachinidae	1	IX-3
Voria	*ruralis* (Fall.)	Tachinidae	1	IX-3
Paradidyma	sp	Tachinidae	1	IX-12
Winthemia	sp.	Tachinidae	3	IX-19
Archytas	sp.	Tachinidae	1	IX-28
Hyalomya	*aldrichi* Tns	Tachinidae	6	IX-30: X-28
Cistogaster	*immaculata* Macq	Tachinidae	1	IX-30
Cistogaster	*occidua* (Wlk.)	Tachinidae	2	X-23
Sphaerophoria	*cylindrica* (Say)	Syrphidae	3	VII-25: IX-28
Eristalis	*arbustorum* (L.)	Syrphidae	5	VII-25: IX-28
Eristalis	*tenax* (L.)	Syrphidae	7	VIII-8: X-23
Allograpta	*obliqua* (Say)	Syrphidae	1	VIII-8
Syritta	*pipiens* (L.)	Syrphidae	8	IX-16: X-23
Syrphus	*wiedemanni* Johns	Syrphidae	2	IX-3: IX-12
Syrphus	sp	Syrphidae	1	X-23
Mesogramma	geminata (Say)	Syrphidae	1	X-23
	Neuroptera			
Chrysopa	*plorabunda* Fitch	Chrysopidae	1	IX-12
	Hemiptera			
Corizus	*lateralis* Say	Corizidae	1	VII-20
Lygus	*pratensis* (L.)	Miridae	4	VII-20: X-17
Lygus	*pratensis oblineatus* (Say)	Miridae	1	IX-2
Lygus	*pratensis strigulatus* (Wlk.)	Miridae	1	IX-6
Plagiognathus	*politus* Uhl	Miridae	5	IX-3: IX-30
Adelphocoris	*rapidus* (Say)	Miridae	9	VII-27: X-21
Peribalus	*limbolarius* Stal	Pentatomidae	1	IX-2

SUMMARY

The list for 1940 embraces 97 species and a few varieties represented by a total of 228 individuals, all of which were insects in the adult state excepting an advanced nymph of the common mirid bug, *Adelphocoris rapidus*. These species belong to six orders—Coleoptera, Hymenoptera, Lepidoptera, Diptera, Neuroptera and Hemiptera. A large part of the total is bees, moths and flies. Members of the holometabolous orders again constitute by far most of the prey, or 92.36 per cent as contrasted with 7.64 per cent Heterometabola. This predominance of Holometabola merely signifies that chrysomelid beetles, moths, butterflies, bees, wasps, ants and many kinds of dipterous flies take as a considerable part of their food the pollen, petals or nectar of flowers and by that practice attract their predatory enemy *Phymata* to the same situations.

Moreover, as in 1938 and 1939, the prey value of the several species composing the list exhibits great plasticity. Were records of the present kind taken for years without end, they would obviously continue indefinitely to be characterized by such variation. The causes lie, in general, in the fluctuations in the climatic and biotic influences that surround the insect fauna everywhere. Some species appear for the first time in this list, while others present in 1938 and 1939 are lacking from it, and those represented consistently in all the three years played changing roles in respect to their quantitative prey value.

FEEDING COMBINATIONS

Of the 228 instances of predation reported for this year, the sex of the preying phymatid was noted in 268. The several preying combinations and their relative frequency are summed up in Table II.

TABLE II

PREYING COMBINATIONS

PREY FED ON BY	NUMBER	PER CENT OF TOTAL	PREY FED ON BY	NUMBER	PER CENT OF TOTAL
Single males	61	22.75	Mating males	0	0.00
Single females	131	48.85	Mating females	5	1.85
Coupled males	6	2.28	Both sexes of mating pairs	1	0.36
Coupled females	51	19.04	Other combinations	6	2.28
Both sexes of coupled pairs	7	2.59	Grand totals	268	100.00%

It will be seen that 71.50 per cent of the 268 prey insects were found in possession of single male or female captors, i. e., Phymatas neither coupled nor *in copulo;* that 19.04 per cent was captured by females of coupled pairs as against only 2.28 by males of couples; that five females engaged in feeding while mating as compared with no males feeding alone in that relation. In one instance, the members of a mating pair fed simultaneously on a small mirid bug, *Plagiognathus politus.*

Counting all the above feeding bugs as individuals, i. e., disregarding the several paired combinations, I find males were concerned in only 81 instances whereas females totaled 199. In other words, 29 per cent of the feeding was done by males and 71 per cent by the females. The corresponding data for 1938 were 25.9 and 74.1, and for 1939, 17.9 and 82.1 per cents. These figures give a three-year average of 24.27 and 75.73 per cent, for male and female, respectively, showing that, on the whole, the females capture and feed approximately three times more frequently than the males. In general they also utilize larger insects than the males secure. In terms of actual quantity of food substance ingested, the females may be conservatively estimated to take four times more quantity of food than the males. More or less complete data taken during the three years show that the sex ratio annually averaged approximately 1 : 1. This normal intersexual disparity in rate of feeding is correlated with the much greater bulk of sexual products, expressed in terms of eggs, developed by the female. This correlation is indicated also by weights of almost 500 males and females collected on seven different dates between July 17 and September 28, the period representing the inception, and rise to the peak, of sexual productivity. On July 17, the average young male weighed 0.0210 gr. and the female 0.0340 gr., or 1.63 times the weight of the male, while on September 2, the respective weights had mounted to 0.0270 and 0.0540—the average female weighing twice the average male. This greater rate of acceleration in weight in the female runs parallel with the greater bulk of sexual products yielded by this sex. Spermatogenesis requires a smaller quantity of nutriment than oögenesis.

In addition to the majority feeding combinations noted above, the following unusual cases deserve brief description.

1. Two males and a female feeding together separately on a *Sphex placidus*.

2. Male and female feeding separately and simultaneously on an *Eristalis arbustorum*.

3. Female of a coupled pair feeding on an adult of *Adelphocoris rapidus* while the mate fed on a chloropid fly, *Madiza* sp.

4. Two males feeding on a screw worm fly, *Cochliomyia macellaria*, while only one of them held the captive.

5. A male holding a wasp, *Psen cressoni*, with one front leg and an anthomyid fly, *Hylemya* sp., with the other. Both captives were dead; had doubtlessly been captured and killed by this bug.

6. A female holding a dead bee, *Halictus versatus*, with one front leg and another bee of the same species with the other. The bug was feeding on the latter captive.

7. The female of a coupled pair had just captured a moth, *Feltia subgothica*—the latter fluttering vigorously as I came upon the scene. Within a minute, the bug drew the resisting moth in reach of her proboscis. In another minute the deadening injection had inactivated the moth. Sitting on his mate's back during this period, the male now moved forward to come in on the kill.

8. A female was found holding to the head and thorax of a tachinid fly and seemed to be feeding. Considering that *Phymata* has not been seen to date to seize dead insects and that the body of the fly was torn raggedly, I suspect some chewing predator—wasp or beetle—had eaten away the abdomen and a part of the thorax of the fly which *Phymata* had captured and killed.

9. A male *Phymata* held with one front leg to the extended siphon of an adult *Feltia subgothica* that had approached a flower of *Aster multiflorus* to feed. Having grasped the siphon near its apex, the bug was unable to draw the moth within reach of his stylets to inject the inactivating fluid. The moth fluttered violently, shaking the plant sharply, and threatened to jerk the bug from his perch. During the subsequent 10 minutes, the moth relaxed at intervals its efforts to escape, and in these lulls the bug renewed, without success, his efforts to make contact with his piercing organs. In the following 15 minutes the moth hung limp except for brief and feeble struggles, and in a few minutes more was dropped by the frustrated bug. Sixteen hours later *Feltia* was dead of exhaustion, while *Phymata* crawled about in perky fashion. At this time, the moth weighed 0.0354 gr., the bug 0.0167, or less than half his captive.

REFERENCES CITED

Balduf, W. V. Food habits of *Phymata pennsylvanica americana* Melin, Canadian Entomologist, March, 1939, 66–74.

More ambush bug prey records, Bul. Brooklyn Entom. Soc., **35**, **1940**, **161–169**.

Life History of *Phymata pennsylvanica americana* Melin, Ann. Ent. Soc. Amer., **34**, **1941**, 204–214.

A NEW GENUS (DELTORYNCHUS) AND TWO NEW SPECIES OF LEAFHOPPERS (HOMOPTERA CICADELLIDAE) FROM MEXICO

DWIGHT M. DeLONG
The Ohio State University

A study of the Mexican leafhopper fauna has revealed many interesting species and records. The material which is herein described is one of the interesting new genera and species.

Genus **Deltorynchus** nov.

Related to *Mesamia* but with a more produced vertex which is flat on the disc with the apex slightly upturned. The pronotum slopes definitely to the vertex. In lateral view the margin is thick and the face is somewhat convexly rounding from the clypeus to upper edge of vertex. The venation is simple in type with the second anteapical cell decidedly longer than the first and narrowed at middle. Genotype *Deltorynchus quadrinotus* n. sp.

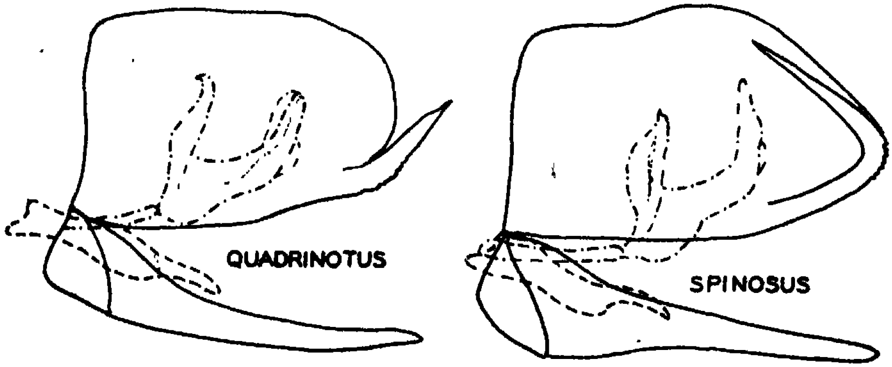


Fig. 1. Lateral view of male genitalia as labeled.

Deltorynchus quadrinotus n. sp.

A yellowish species marked with orange and white and with black spots on margin of vertex. Length 5 mm.

Vertex produced and bluntly angled, about one-fifth wider between eyes than median length. Head including eyes decidedly narrower than pronotum. Elytra long and narrow.

Color.—Vertex orange, margin more yellowish with four large black spots on margin about equidistant from each other and from the eyes. Pronotum yellow with a broad median transverse orange band. Scutellum orange on anterior half and yellow on posterior half. Elytra yellow subhyaline marked with brown except a large pale triangular spot on costa just before the middle and a smaller pale costal spot just before apical cross veins. Large white areolar spots are prominent on clavus and in base of apical cells. Face and beneath bright yellow unmarked.

Genitalia.—Male plate rather long, slightly indented on outer margin at about half its length then tapered to a blunt apex. Style rather broad at base, apical fourth narrow, apex curved outwardly. Aedeagus broadly U-shaped, rather thick at base with a long portion projecting dorsally. The apical half is narrowed abruptly curved dorsally at two-thirds its length with the apex bluntly rounded. The pygofer bears a heavy black spine on the ventral apical margin which extends caudally and bears several tooth-like spines on the inner margin.

Holotype male and paratype males from Iguala, Gro., Mexico, September 11, 1939, and October 25, 1941, collected by C. C. Plummer, E. E. Good and the author. Paratype males are also at hand from Balsas, Gro., Mexico, August 15, 1930 (M. F. 1754) collected by J. Parra. One paratype male collected on the Cuernavaca Acupulca Road, August 24, 1936, by Ball and Stone is in the Ball collection. Holotypes and paratypes in author's collection.

Deltorynchus spinosus n. sp.

In general form, appearance and coloration resembling *quadrinotus* but with shorter, more bluntly angled vertex and with distinct male genitalia. Length male 5.5 mm.

Vertex rather broad and bluntly angled, one-third wider between eyes than median length.

Color.—Vertex yellow, tinged with orange, with four black spots on margin. The two at the apex are larger and proximal with a smaller spot halfway between apex and eye on either side. Pronotum yellow with a broad transverse median band which is about half as wide as length of pronotum. Pronotum yellow, basal angles brown. Elytra white with clavus, a transverse band just posterior to middle and another across apex of elytra brown. The transverse bands reach to the costa forming two large white costal spots one either side of the median cross band. Numerous white circular spots throughout the brownish coloration, especially larger and conspicuous on the clavus. Face pale yellow.

Genitalia.—Male plates triangular, concavely indented just beyond middle then tapered to a pointed apex. Aedeagus U-shaped with the posterior arm of the "U" longer than the basal portion. In lateral view the basal portion is broad with a dorsally directed process which arises at the basal dorsal angle and is short and rather broad. The basal portion is abruptly narrowed at about half its length, then curved to form a long tapered and apically pointed process. The dorsal caudal margin of the pygofer is roundedly sloping to the basal caudal angle from which a long black spine arises and curves dorsally around the caudal margin of pygofer and extends to the dorsal margin of the pygofer.

Holotype male collected at Cuautla, Mor., Mexico, August 27, 1937 (M. F. 6247) by Dr. Dampf, in author's collection.

STAINING INULIN CRYSTALS IN PLANT TISSUES[1]

GLENN W. BLAYDES
The Ohio State University

Inulin, a levulosan, is found widely distributed among numerous angiosperm families. This carbodyhrate occurs in solution in the cell sap of some species, in others it accumulates as an amorphous material, and in some plants inulin crystals are found deposited in living tissues. Inulin stains brown in iodine and will not reduce Fehling's solution. It may be precipitated as sphaero-crystals within the cells of some tissues when immersed in 70 per cent ethyl alcohol. The enzyme inulase in plant tissues hydrolyzes inulin to fructose. A microchemical test for inulin consists of treating freehand sections of plant tissues with a drop of 15 per cent thymol (15 grams of thymol dissolved in 85 cc. of 95 per cent ethyl alcohol). This treatment is followed by a drop of concentrated sulphuric acid. If inulin is present a bright red color is evident at once and soon disappears. If the inulin is in the form of crystals the red color becomes evident as the crystals dissolve.

For class study, freehand sections are usually prepared and examined as temporary mounts, or they are mounted in glycerine jelly. These preparations are often unsatisfactory since beginning students have trouble finding the transparent crystals. Inulin crystals in glycerine jelly preparations often dissolve within a few months after mounting.

The following method has been devised for the preparation of permanent microscopic mounts with the inulin differentiated, by its reddish pink color when stained with phloxine. Inulin crystals in tissues prepared by this method 10 years ago are as satisfactorily differentiated and brilliantly stained now as when made. The aniline blue counterstain has faded in these balsam mounts. It is probable that this fading of the counterstain can be counteracted to some extent by mounting in xylene clarite. Further tests with clarite as the mounting medium are in progress. Bismarck brown Y (certification No. CN-3) may be used as a counterstain instead of the aniline blue. It is much more permanent, but the color contrast is not as satisfactory as with the aniline blue. A saturated solution of Bismarck brown Y in 70 per cent ethyl alcohol may be used. Staining for 3 minutes gave the most satisfactory results.

Dandelion (*Leontodon taraxacum* L.) root is excellent as a source of tissue containing inulin. These roots should be collected during the summer or autumn. Roots collected during the winter period (January and February) have not proven satisfactory, apparently because of the low inulin content. Several fixatives have been tried, including formalin-acetic acid-alcohol and Carnoy's fluids. Dissolution of the inulin crystals occurred in all these fixatives. At length 70 per cent ethyl alcohol was resorted to as a killing agent, and at the same time causing crystallization of the inulin. Some plasmolysis of cortical cells occurred. However, this is of little importance since the preparation is intended as a food storage demonstration. Pieces of dandelion roots were cut into appropriate lengths and dropped into the alcohol. A faucet vacuum pump may be used to advantage in removing air from the tissues. Wittlake's (2) vacuum apparatus is ideal for this purpose.

---

[1] Papers from the Department of Botany, The Ohio State University, No. 459.

The following schedule outlines the procedure in detail:

1. Use dandelion roots which are approximately 5/16" in diameter and cut into blocks of about the same length.
2. Place the pieces of root in 70 per cent ethyl alcohol (70 parts of 95 per cent ethyl alcohol to 25 parts distilled water).
3. Remove air from the tissues by a faucet vacuum pump. Allow the alcoholic treatment to continue about 72 hours after pumping, or longer if more convenient.
4. Complete the dehydration in 80, 95 and 100 per cent alcohols at intervals of 3 hours.
5. Transfer root pieces to ether-absolute ethyl alcohol (half and half mixture) for 3 hours.
6. Pass through a 2, 4, 6, 8, 10, 12, 14 and 16 per cent collodion[2] series at intervals of 24 hours, using the hot method of Wetmore (1).
7. Imbed in collodion on hardwood blocks and harden in chloroform for 12 hours.
8. Store in glycerine-alcohol (half glycerine to half 95 per cent ethyl alcohol) for 3 days or until needed.
9. Section on a sliding microtome. Good sections for general study may be made from 24 to 30 microns in thickness. The knife should be sharpened after cutting about 5 sections since the inulin crystals rapidly dull the edge. Keep the knife and tissue block flooded with the glycerine-alcohol mixture
10. Transfer the sections to 95 per cent ethyl alcohol, rinsing 5 or 6 times to remove the glycerine.
11. Transfer to a half and half mixture of ether and absolute ethyl alcohol to remove the collodion.
12. Rinse in 95 per cent alcohol.
13. Stain in phloxine[3] (1 gram to 100 cc. of 90 per cent ethyl alcohol) for about 10 minutes.
14. Rinse sections in 95 per cent alcohol to remove the excess phloxine.
15. Counterstain in aniline blue (1 gram to 100 cc. of 95 per cent ethyl alcohol) for 15 to 30 seconds. Care must be taken to prevent overstaining in the aniline blue. The inulin should remain a pinkish red color. If the inulin crystals absorb too much of the blue stain, restain by transferring to the phloxine again.
16. Rinse in 95 per cent ethyl alcohol.
17. Transfer to absolute ethyl alcohol for 3 minutes.
18. Clear in xylene for 5 minutes. Wintergreen oil (methyl salicylate) may be used to advantage before the xylene treatment. This must be short, however, since it appears to intensify the aniline blue and to cause the inulin crystals to appear purplish.
19. Mount in neutral balsam, or in xylene clarite.

REFERENCES

(1) **Wetmore, R. H.** The use of collodion in botanical technic. Stain Tech., 7: 37–62. 1932.
(2) **Wittlake, Eugene B.** An efficient vacuum apparatus for microtechnic. Ohio Jour. Sci., 42: 65–69. 1942.

---

[2] Collodion Cotton or Pyroxylin, prepared and sold by the J. T. Baker Chemical Co., Phillipsburg, N. J., is excellent and inexpensive for this purpose.

[3] The phloxine originally used was manufactured by Coleman and Bell, Norwood, Ohio. More recent tests have been made with phloxine from The National Aniline & Chemical Co., New York, N. Y., certification No. 9, total dye content 82 per cent.

A DEVICE FOR OBSERVING LIVING FISH EMBRYOS AT CONTROLLED TEMPERATURES

JOHN W. PRICE
Department of Zoology and Entomology
The Ohio State University

In many species of fishes, living embryos together with their yolk sacs lie partially suspended within the perivitelline space. They rotate freely when the eggs are disturbed, but otherwise they assume a position of equilibrium in relation to the center of gravity. During cleavage stages, the early blastomeres and later the blastoderm at the animal pole are uppermost. During gastrulation, the center of gravity may shift as oil globules disappear or coalesce and the embryo grows forward from one side of the germ ring. As a result, before the hatching stage is reached, the embryo at different times may appear to be attached to the yolk at its side or below or above it.

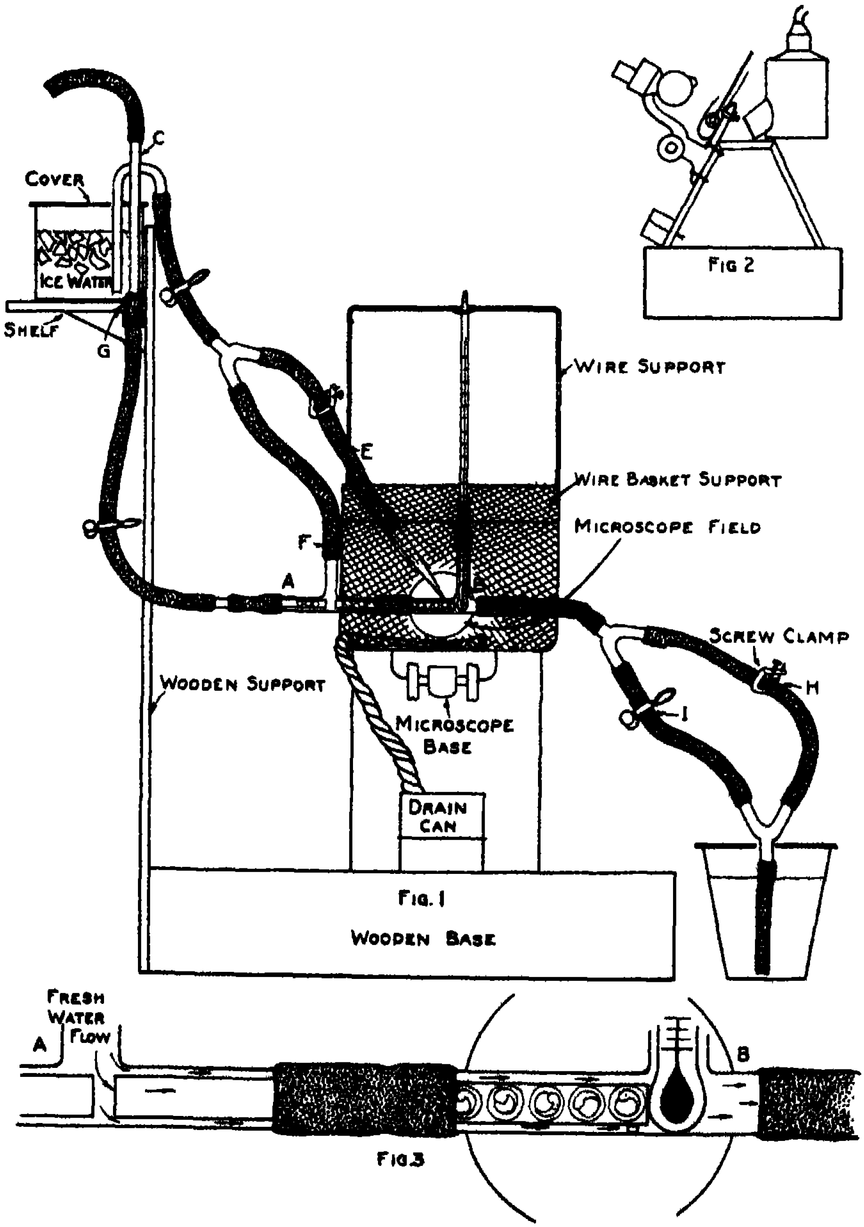
Such changes in relative position of the fish embryo in relation to the yolk sac make desirable its observation through a microscope held in a horizontal position. At such an angle, the embryo may be viewed in profile against an illuminated background, rather than by reflected light against the yolk as a background. From the vertical position, the observation of cell boundaries of the superficial blastomeres and the topography of the relatively translucent embryo is not satisfactory.

The device described below permits the observation of such embryos in profile from the side view, and at the same time under controlled temperature conditions.

The essential features of this apparatus, shown in the accompanying figures, include a series of glass tubes which convey non-adhesive fish eggs into the field of vision of a binocular dissecting microscope. The eggs are viewed from the side. A lighted background throws the blastodisc or embryo into bold relief. Prechilled water, flowing over these eggs at a controlled rate, makes possible the retention of temperatures below that of the surrounding air and provides an oxygen supply to the eggs while they are being examined.

The design of the apparatus is evident for the most part from the drawings of the front view (Fig. 1) the side view (Fig. 2) and the detail of the tubes that bring the eggs into the field of vision (Fig. 3). The box-like wooden base has four sides. From its front and rear sides rise standards at the angle desired to give a slight tilt to the microscope bolted to the front at the top (See Fig. 2). The U-base of the microscope projecting above the wooden base gives an anchorage to the wire basket support of the tubing and thermometer. A focusing lamp in its housing is mounted on a vertical rod behind the wire basket, and the flat top of the wooden frame permits the use of a liquid heat filter in front of the lamp housing.

The rubber tubing, the straight glass tubing and the Y- and T-tubes used are of standard laboratory design. Metal screw clamps at *E* and *H* are used for maintaining a controlled steady flow of water, while pinch clamps are used elsewhere to obtain an on and off effect. The two T-tubes between positions *A* and *B* in Figs. 1 and 3 are of such a size as to permit the insertion of the base of a thermometer at *B* and of two straight glass tubes at *A* which carry the eggs as desired into the field of vision at B. These inside tubes are just large enough to carry eggs freely in single file without their piling up. The thermometer bulb acts as a barrier to their further passage at *B*. The rubber tube which seals the union between the T-tube and the stem of the thermometer permits the thermometer to be drawn slightly out of the T-tube sufficient to clear the end of the horizontal tube and permit the passage of eggs out of the system into the catch basin to the lower right, when the clamp at *I* is opened.



Figs. 1–3. Apparatus for observing living fish embryos at controlled temperatures. Figure 1 shows the front view; fig. 2, the side view; fig. 3, detail of tubes that convey eggs into the field of vision.

The temperature inside the egg chamber, *A–B*, is read directly from the thermometer at *B*. The wires of a thermocouple may be wrapped around the bulb of the thermometer and their free ends connected to a galvanometer. The writer made such thermocouple readings with a Leeds and Northrup potentiometer, but when these readings were found repeatedly to be in close agreement with those of the thermometer used, the thermocouple was dismounted.

Effective temperatures below that of the surrounding air are obtained by siphoning prechilled or ice water from the supply vessel at the upper left along the route *F*, *A–B*, *H*, to the catch basin at the lower right. As water enters the horizontal double tubing from *F*, it flows through both the inner tubing over the eggs and outside this tubing. At the point of water entrance, *A* in Fig. 3, it is essential to have an open joint in the inner tubing, permitting the entrance of water as shown. The rate of flow of water is controlled by regulating the screw clamp at *H*. Temperatures on the eggs at *B* are elevated by a decrease and are depressed by an increase in rate of water flow. A further depression of the temperature may be brought about by packing the wire basket with cracked ice. Waste water from the melted ice follows the wicking into the drain can. The moisture that collects on the outside of the egg-conveying tube when temperatures below the dew point are reached is flushed off by a steady flow of water onto that surface from the pipette *E* regulated by the screw clamp above it.

Eggs to be observed with this device are introduced into the system by removing the glass tube *C* from its lower connection at *G*, and using it as a siphon for drawing eggs from the incubation jar. This tube also should carry eggs in single file. This tube, once filled with eggs, is connected with the rubber tube and held vertically in a clamp at *G*. During this operation, the flow of ice water from the supply jar is momentarily checked by the pinch clamp above the main line at *F*. The pinch clamp below *G* is then opened and the eggs pass into the horizontal tubing. The two lengths of inside tubing at *A* are then held end to end by hand pressure, and the eggs are drawn into the observation area of the tube *A–B*, against the bulb of the thermometer at *B*.

Preliminary to the examination of eggs, certain adjustments must be made. These include the focusing of the lamp, the placement of its water filter, the filling of the wire basket with ice, and the regulation of the temperature at *B* as desired by starting the siphon flow of water and its regulation at the screw clamp *H*. In addition, the screw clamp above *E* is adjusted to produce a water film over the outside of the observation tube. Once these preliminary adjustments are made, a dozen or more eggs may be introduced. Since the tube *A–B* is free to be moved in the wire-basket frame, it can be shifted from left to right to permit the examination of a number of eggs simultaneously. Once examined, eggs may be released by elevating the thermometer bulb as described above, and additional eggs be brought into the field of vision.

This device, while undoubtedly still subject to considerable refinement, has proved especially helpful in bringing such eggs into a profile view for protracted periods of observation. It was developed as a means of enabling the writer to observe the chronological sequence in fish embryonic bodily movements that are characteristic of certain egg stages, and to study bloodflow and heart rhythm at given desired temperatures. For prolonged observation of fish embryos incubated at temperatures below that of the laboratory air, a continuous flow of fresh aerated water controlled as to temperature is desirable. The above device has been found to provide these conditions reasonably satisfactorily. It lends itself for use with non-adhesive fish eggs of different diameters, since the egg-conveying horizontal tube may be replaced by one of any desired diameter, within limits usually encountered in such material.

Historical Geology

The late Professor Charles Schuchert hoped to complete within his lifetime a truly comprehensive treatise on the historical geology of North America, although it now seems that three volumes, the second of which has just appeared, are to constitute his contribution. But what a monument to his life's devotion to stratigraphy and paleontology these will be,—truly the stratigrapher's *vade mecum*! This is no cold lexicon of stratigraphic units, but a warm synthesis of the ever more complex facts and inferences concerning the stratified rock record of this continent, based upon years of field work and digests, begun in 1904, of hundreds of geological books and papers. The first volume, appearing in 1935, dealt with the Antillean-Caribbean region, including the Gulf Coastal Plain area. The second volume, summarily reviewed here, covers the 30 eastern and central states, including Texas. The third volume, which the publishers assure us is well advanced in preparation, will discuss New England, the Maritime Provinces, the rest of eastern Canada, central and arctic Canada, the Arctic Archipelago, and Greenland, "together with the philosophical conclusions and paleogeographic maps." In his introduction to the second volume, Professor Schuchert bequeaths to his successors "the Cordilleran wonderland." Nor has he made any attempt to give pre-Cambrian local histories, or any of the Pleistocene.

The plan of the book is simple and direct: the stratigraphy of each state is considered separately, but each is related to its neighbors and stratigraphic province. They are grouped in eight sections, following an introductory chapter on stratigraphic terminology: (1) New York, the standard for correlation of the Ordovician, Silurian, and Devonian in the eastern and central United States,—"No more fossiliferous or better understood formations exist than those of New York"; (2) the eleven states lying across the Appalachian geosyncline beginning with Pennsylvania and New Jersey and extending down and around to Mississippi; (3) the Atlantic Coastal Plain; (4) the states athwart the Cincinnati geanticline; (5) the states conditioned by the Ozark dome; (6) Wisconsin and Minnesota; (7) the eastern plan states; and (8) the states north and west of the borderland Llanoria. After introductory remarks on the general geological relations of each section, there follow separate chapters on the states, each of which includes an historical résumé of geological work, the major structural features, and the stratigraphic sequence, the last being a detailed catalogue of the rock units, beginning with the oldest and including the course and date of the name, lithology, thickness, abundant references to significant literature (especially since 1910), important fossils, and correlations. The number of stratigraphic units thus treated is around 2500. Where significant stratigraphic breaks occur between formations, they are indicated and their meaning discussed. In spite of elimination of superfluous verbiage and employment of a standard set of abbreviations, the whole, as may be expected, forms an imposing volume. The three plates display portraits of leading American geologists; the 78 correlation charts and 123 figures, mostly geologic maps and sections, sharply focus stratigraphic relations.

There can be no criticism of this work as a whole,—there is no similar modern compendium of American stratigraphy treated from the standpoint of sequence and significance,—and its tremendous value to all geologists, at home and abroad, is at once apparent. There will be innumerable critics of special points: "He hasn't mentioned so-and-so's work in such-and-such county," "He has incorrectly quoted my results on the forams of this-and-that well," "Apparently he never saw the section on thus-and-so creek," and so on. No one can hope to bring together so much data without occasional nods, and to sift it without missing a few grains or even occasionally dropping a brick. Will any of the rest of us ever have the courage and fortitude to produce a comparable landmark in American geology? Probably not.—*J. W. Wells.*

Stratigraphy of the Eastern and Central United States, by Charles Schuchert. xvii—1013, 78 charts, 123 figs., 3 pls. New York, John Wiley and Sons, 1943. $15.00.

ON SOME AMERICAN AND ORIENTAL EARTHWORMS

PART I

G. E. GATES,[1]
Judson College, Rangoon, Burma, and
The Ohio State University, Columbus, Ohio

This article contains descriptions and notes on distributions of earthworms sent recently to the Zoology department of Ohio State University for identification. Included among this material is the first specimen of the large Indian earthworm, *Drawida grandis* (Bourne) 1886, that has been available for study since the species was first described; the first specimens of *Drawida* from the type locality of *D. barwelli* (Beddard) 1886 that have been examined since the erection of that species; several specimens of one or possibly two species of the little known Philippine genus *Plionogaster* and material belonging to new species of five Moniligastrid or Megascolecid genera, including five new species from the United States. Although specific identification of the Plionogasters is at present impossible, study of this material has enabled recognition of the nature of the excretory system which is of a mixed type with both meganephric and micronephric tubules, the meganephridia enteronephric and resembling those in *Lampito*.

In connection with the section on *Diplocardia*, attention is once again (*vide* Gates 1929*a* and *b*) directed to the fact that much work, even of the most elementary nature remains to be done on the earthworms of the United States. Very little is known of the earthworms in that portion of the country below the southern limit of glaciation where native species are most to be expected It may be permissible to express a hope that if war, inflation or high taxation prevent continued organization of costly expeditions to distant tropic and arctic regions, American zoologists will turn their attention to their own front yards, for instance to Alabama, South Carolina, Tennessee, Kentucky, Virginia, Arkansas, Oklahoma and Kansas with no records of *Diplocardia* hitherto, Mississippi and Texas with one record each hitherto, Georgia with two records, North Carolina with four records. Even in those northern states where some work on distribution has been done (Illinois, Indiana and Ohio), the gross morphology of the earliest named species is so inadequately characterized that recognition of intrageneric relationships is difficult or impossible. Attention of those in museums and biological surveys is also directed to the fact that types of nine or ten of the few known endemics are in European museums, that types of other endemics were probably destroyed in the San Francisco earthquake, and that the location and condition of other types is unknown. With possibility of further destruction of types during the war and to provide reference material for local workers, series from all of the type localities should be collected at the earliest opportunity.

The writer is indebted to Prof. R. C. Osburn for the privileges of the Zoology department during the academic year 1940–41, and to Prof. W. M. Barrows for the collection and careful preservation of the Florida forms.

---

[1] Visiting Professor in the Department of Zoology and Entomology of The Ohio State University, 1940–41.

Family MONILIGASTRIDAE

Genus DRAWIDA Michaelsen 1900

Drawida bournei (Michaelsen) 1897

Material examined.—Slides from the U. S. Nat. Mus. with sagittal sections of a half portion of an anterior end of a specimen, presumably from Ceylon, presented to Prof. Frank Smith by Dr. W. Michaelsen.

Internal anatomy.—Gizzards appear to be in xv-xviii. Recognition of boundaries of the male funnel is difficult but the testes appear to be attached to an anterior portion of the funnel which is located immediately above the region of attachment to the testis sac of septum 9/10. The vas deferens is certainly looped in front of 9/10 (probably also behind 9/10) and passes into the anterior face of the prostate without first passing into the parietes. The prostate is a longitudinally ellipsoidal body sessile on the parietes. The spermathecal duct is slightly thickened in the parietes, the widened portion ovoidal with narrower end ectally. The oviducal funnel is continued dorsally on the septum to a point just above the aperture into the ovisac.

Remarks.—*D. bournei* is one of a group of forms with "muscular" prostates. The taxonomic status of each of these species except *D. grandis* is still unsettled. It is very doubtful if information of much importance in connection with these problems can be obtained from sections such as those of *D. bournei*. After study of that material and of sections of *Syngenodrilus lamuensis* Smith & Green 1919 and of the literature on other species known only from similarly prepared sections as well as of sections prepared by professional technicians the author is of the opinion that Stephenson (1923, p. 6) was quite correct as to the advisability of dissection in the study of unique types and limited series.

Drawida grandis (Bourne) 1886

Material examined.—Valley above dhobi quarter, 300 feet above town towards Government House, by dam, Ootacamund, South India, November 15, 1932, 1 anterior fragment (*ca.* 180 mm. long). G. E. Hutchinson per Dr. Grace Pickford.

External characteristics.—Diameter 11 mm. Pigment unrecognizable. Prostomium prolobous, segment i partially retracted into ii. Nephropores begin on iii, those of vii-ix slightly displaced dorsally, posteriorly in *cd*, not displaced on xii, apparently functional on x. Clitellar coloration unrecognizable. Setae are closely paired, *ab* and *cd* about equal, $aa < bc$. On viii the setae are one mm. from 7/8 and 4½ mm. from 8/9. Setae are located on the anterior halves of the segments throughout all of the fragment.

The spermathecal pore of one side is a transversely placed slit on 7/8 on *c*, with protuberant wrinkled margins. On the other side the pore is on the ventral face of a rather conical protuberance. The female pores are on 11/12, about on *b*. The male pores are transversely placed slits just lateral to *b*. No genital markings.

Internal anatomy.—Septa 5/6-8/9 are thickly muscular. Gizzards are in xix-xxiii, but with strongly marked muscularity of the oesophagus in xvii and xviii. The postgizzard portion of the oesophagus is bent into a U-shape with the concavity facing the left side, the inner wall provided with high vertical ridges crossed by longitudinal furrows. The intestine begins in xxxiv. No typhlosole.

The last pair of hearts is in ix. Paired commissures are present on the posterior faces of 8/9-9/10. The extra-oesophageals are lateral to the hearts. Nephridia are present in x.

The left testis sac is displaced behind the ovarian segment. The vas deferens is in a number of fairly long hairpin loops on the anterior face of 9/10 and more closely compacted, shorter loops on the posterior face but the total mass of the loops is much smaller than that of the testis sac. The ectal portion is iridescent and passes into the median face of the prostate close to the parietes. The prostate is disc-shaped, of circular outline, about 2½ mm. in diameter, sessile on the parietes, the duct slightly and gradually narrowed ectally within the parietes, the greatest thickness more than half that of the prostate. The lumen of the prostate is a narrowly slit-like, horizontal cavity, the roof with three irregular ridges. On the center of the floor there is a tiny slit the margins of which are wrinkled, this portion possibly capable of protrusion through the male aperture as a sort of penis.

The spermathecal duct passes into the septum fairly high up in viii and deep in the parietes is slightly thickened, the atrial portion rather elongately top-shaped. The lumen of the duct remains narrow but has an irregular course through the greater portion of the length of the atrium, in the ectalmost portion abruptly widened and with irregular walls. In this portion there is a tiny conical protuberance. Segment xi is reduced to a horseshoe-shaped ovarian chamber. Ovisacs extend into xii or xiv.

Remarks.—Ovisacs are contracted, with thick walls, the lumen filled with a felted, dark brown material. There are no free ova in the ovarian chamber. Spermathecal ampullae are distended. The worm is probably in a late postsexual stage.

Drawida sp. 1

Material examined.—Valley above dhobi quarter, 300 feet above town towards Government House, by dam, Ootacamund, South India, November 15, 1932, 1 mature specimen. G. E. Hutchinson per Dr. Grace Pickford.

External characteristics.—Length 132 mm. Diameter 6 mm. Pigment unrecognizable. Prostomium prolobous, retracted under iii. Nephropores begin on iii, those of viii slightly displaced dorsally, not displaced on xii, apparently functional on x. Clitellar coloration unrecognizable. The setae are paired, *ab* and *cd* about equal, *aa* and *bc* about equal.

The spermathecal pores are transversely placed slits, not minute, on 7/8 in *cd*. Female pores are on the anteriormost margin of xii just lateral to *b*. Male pores are transversely placed slits on 10/11 just lateral to the seminal grooves and hence in the lateral half of *bc*. The grooves are longitudinally placed, rather irregular, clearly marked and fairly deep with slightly tumescent margins, extending across almost all of x and to the setal arc of xi, crossing 10/11 about at mid *bc*. No genital markings.

Internal anatomy.—Septa 5/6–8/9 are thickly muscular. Gizzards are in xvi-xxi, the one in xvi small. The intestine begins in the region of xxxi-xxxiii. Enterosegmental organs are present. No typhlosole.

The last pair of hearts is in ix. There is a pair of commissures on the anterior face of 8/9. Extraoesophageal trunks are lateral to the hearts. Nephridia are present in x.

The right testis sac is dislocated posteriorly, the left sac approximately equally in ix and x. The vas deferens is fairly long and looped on both sides of 9/10 but the mass of the loops is much less than that of the testis sac. No slender portion noted. The vas passes directly into the anterior face of the prostate near the ental end without first passing into the parietes. The prostates are rather ovoidal but with bluntly rounded ends, the ectal end broader, protuberant into the coelomic cavity to a height of two mm., leaning slightly mesially, the duct restricted to the parietes and on the median side of the ventral face of the gland. The glandular portion (coelomic) is in the form of a crescentic to U-shaped band of pink, coarsely granular appearance placed transversely across the prostate, reaching mesially and laterally nearly to the parietes, the anterior and posterior faces of the prostatic capsule smooth and bare. Internally the prostate is lined with a slightly pink, soft layer. The cavity is closed off ventrally and is eccentric due to the greater thickness of the floor. Into the transversely slit-like cavity within the body wall there is protuberant a rather indefinite, roughly conical but wrinkled bit of tissue, possibly a penis protrusible to the exterior through the male pore.

The spermathecal atrium is thickwalled, rather conical but with bluntly rounded dorsal surface, protuberant into the coelomic cavity of viii, directed posteriorly, smaller than the prostates. The spermathecal duct passes into the median face of the atrium somewhat below the ental end. The lumen is U-shaped in horizontal section due to the presence on the anterior wall of a vertical ridge. The ovarian segment is reduced to a horseshoe-shaped chamber. Ovisacs extend into xv.

Remarks.—Ovisacs are distended, yellowish and filled with ova but there are only a few loose ova in the ovarian chamber. Spermathecal ampullae are distended. Deferent ducts are slightly iridescent. The worm appears to have passed the peak of sexual activity.

Distinguished from *D. matthai* Michaelsen 1910 and *sulcata* Michaelsen 1907, the other species of the genus with seminal grooves, by characteristics of prostates and spermathecal atria of sufficient importance to warrant erection of a new species. The single specimen has been dissected too drastically to be of value as a type.

Drawida sp. 2

Material examined.—Manila, Philippine Islands, October, 3 juvenile specimens. Zacharias de Jesus per Prof. R. C. Osburn.

External characteristics.—Length to 75 mm. Diameter to 2½ mm. Unpigmented. Prostomium prolobous. Nephropores posterior to xii, when recognizable, are in *cd*, on viii slightly dorsal to *d*, still less so on vii and anteriorly, not seen on ix-xii. Setae begin on ii but are partly lacking as far back as x; on xx, $ab = cd$, $aa < bc$, *dd* ca. = ½C but slightly greater posteriorly.

The spermathecal pores are transversely placed slits with slightly wrinkled margins on 7/8, on or just median to *c*. Female pores are on *b*, just behind 11/12. Male pores are transversely placed slits about in line with 10/11 on the ventral ends of conspicuously protuberant, columnar porophores seated across 10/11, slightly nearer to *c* than to *b*, the porophores not distinctly demarcated laterally and mesially but apparently reaching nearly to *b* and *c*, sharply demarcated anteriorly and posteriorly by transverse furrows, the portion belonging to xi probably slightly larger than that belonging to x.

Genital markings are a pair of longitudinally placed areas of elliptical outline and epidermal thickening, sharply demarcated, in the lateral half of *bc* on x, reaching anteroposteriorly nearly to 9/10 and 10/11. In addition there is just anterior and posterior to each male porophore a slightly depressed, indistinctly demarcated area of greyish translucence or especially homogeneous opacity.

Internal anatomy.—Septa 5/6-8/9 are thickly muscular. Gizzards are in xii-xiv (1), xiv-xvii (1), xv-xvii (1). The intestine begins in xxvi (1), xxvii (1), xxviii (1). No typhlosole.

The last pair of hearts is in ix (3). There are paired, vertical commissures on the posterior faces of 8/9 and 9/10. Extra-oesophageal trunks are lateral to the hearts. Nephridia are on the posterior faces of the septa and reach up to the dorsal blood vessel. Preseptal funnels are close to the ventral parietes in the region of *ab*. Nephridia apparently are lacking in x.

The testis sacs are constricted by 9/10 with approximately equal portions in ix and x. The vas deferens is very short, without loops in ix where it passes around the heart, with several loose hairpin loops in x, passing directly into the anteromedian aspect of the prostate slightly above the parietes without first passing into the body wall (3). The prostates are sessile on the parietes, the capsule whitish, top-shaped, an almost spheroidal portion sessile on the body wall, an antero-posteriorly flattened duct within the parietes. The lumen is transversely slit-like in horizontal section. The prostates may be slightly bent over mesially or anteromesially.

Segment xi is reduced to a horseshoe-shaped ovarian chamber (2 largest specimens). Ovisacs, even in the largest worm, are juvenile. There are no spermathecal atria nor is there any recognizable enlargement of the duct within the parietes.

Remarks.—Testis sacs are well developed in all three specimens. In the smallest worm the spermathecal ampullae are just recognizable as slight widenings of the ental ends of the spermathecal ducts, and ovisacs do not reach across xii. In the other worms the spermathecal ampullae are filled with whitish material but the ovisacs which extend into xiv are still juvenile. The vas deferens is of about the same length in all three specimens. Except for the ovisacs sex organs appear to be fully developed.

Manila is the type locality of *D. barwelli* (Beddard) 1886 but little of taxonomic value is known of that species (*vide* Gates 1937).

Genus DESMOGASTER Rosa 1890

Desmogaster ferina sp. nov.

Material examined.—Beneath brookside log, Tingpai, Myitkyina district, Burma, November, 1 juvenile and 1 larger, possibly fully grown specimen. F. D. Forbes.

External characteristics.—Length 137–171 mm. Diameter 4–5 mm. Unpigmented Each specimen is coiled in a rather spiral fashion and is dorsoventrally flattened except for a short anterior region. Prostomium prolobous. Secondary annulation begins on v (2), one deep, presetal secondary furrow present on each of segments v-xii.

Setae are lacking on the anteriormost segments, beginning on ix on the smaller specimen where only *c* and *d* of the left side are lacking, on x of the larger worm where both couples of the left side are lacking, and are small, closely paired, *ab* and *cd* about equal, *aa* much larger than *bc*, *dd* probably slightly greater than ½C. On one or two segments anterior to x or ix a transversely placed, greyish translucent line at the approximate sites of the ventral couples is visible.

Nephropores, when visible, are on the anterior margins of the segments, in *bc*, the location variable, nearer *b*, at mid *bc*, or nearer to *c*.

Bithecal, the spermathecal apertures represented, on the larger specimen, by minute, circular pores on 8/9, about on *c*. The male pores are small, transversely placed slits on 11/12 and 12/13, slightly median to *c*. Female apertures are transversely placed slits on xiv, quite definitely behind 13/14 and slightly lateral to *b*.

Internal anatomy.—Septa 5/6–9/10 are thickly muscular, funnel-shaped, apices directed posteriorly.

Gizzards are six in xx-xxv or seven in xx-xxvi.

Extra-oesophageal trunks are first recognizable in v from whence they pass posteriorly just lateral to the hearts and into the subneural vessel in xvi. Anterior to this junction the subneural is very slender and recognizable for only a short distance. On the posterior faces of 10/11 and 11/12 there are commissures from the extra-oesophageal trunks to the dorsal vessel. The last pair of hearts is in xi (2). Hearts or heartlike commissures are present in v-x but those of v-vii have not been traced to the ventral trunk.

Nephridia are present from iv posteriorly, the ducts, in the postgenital segments at least, passing into the parietes just behind the septa in the region of *ab*.

Paired testis sacs are present in the usual locations, in 10/11 and 11/12. The vas deferens is short, and drops directly, without any real looping, to the ventral parietes into which it enters just behind the septum, in *ab*. The prostates are bent over mesially or medioposteriorly in xi and xii, elliptical in cross section, about two mm. long (in the larger worm), the ental end bluntly rounded. In cross sections two canals are visible, one central or nearly so and slitlike to shortly elliptical, the other much smaller, eccentric and more nearly circular.

Segment xiii is reduced to a horseshoe-shaped ovarian chamber (2). The right ovisac of the larger worm is lateromesially flattened and reaches into xx. The spermathecal ampullae are fairly large, flattened discs, about 1½ mm. in diameter, with heart-shaped outline, on the posterior face of 8/9, the entalmost portion of the duct located in the ventral notch very slightly thickened. Underneath the ampulla the duct is in several hairpin loops, an ectal portion of the duct within septum 8/9. The duct is not widened within the septum or parietes and there is no atrium.

Remarks.—The larger specimen with an ovisac extending into xx may be of adult size but the ovarian chamber and the ovisacs contain no free ova, indicating that sexual maturity has not been attained. Both testis sacs of the left side and the right posterior sac are dislocated to positions behind the ovarian chamber and median to the ovisacs. The absence of ovisacs, as well as the small size of the other reproductive organs, proves the juvenile condition of the second specimen.

The prostate is actually an elongate, hairpin loop of the vas deferens, the two limbs of the loop enclosed in a common sheath or sheaths, the ectal limb of the loop slightly thickened.

D. ferina is distinguished from *D. planata* Gates Gates 1931 by the absence of spermathecae in viii, from *D. doriae* Rosa 1890 by the location of the spermathecae in ix, and from *D. albalabia* Gates 1930 by the absence of spermathecae in viii and the erect prostates. In absence of clitellate individuals or specimens known to be fully adult a satisfactory diagnosis cannot be given.

Family GLOSSOSCOLECIDAE

Genus PONTOSCOLEX Schmarda 1861

Pontoscolex corethrurus (Fr. Müller) 1857

Material examined.—Manila, Philippine Islands, October, 13 juvenile and 14 clitellate specimens. Zacharias de Jesus per Prof. R. C. Osburn.

External characteristics.—The first setigerous segment is not recognizably marked off from a peristomium (which may be retracted) but is long and with the setae located nearer the posterior margin. In segmental enumerations the second setigerous segment is assumed to be iii. The anterior segments are strongly contracted so that nephropores are first visible on vi, and from there posteriorly about on *c*. The clitellum extends from an anterior portion of xv (9) or a posterior portion (5) onto xxiii (14).

Spermathecal pores are minute, in line with the nephropores, on 6/7–8/9 but are unrecognizable until after spermathecal ducts have been dissected out from the parietes. Female pores apparently are on 14/15, median to *a* but closer to *a* than to each other (1 specimen only). Male pores are unrecognizable.

Thickened "ridges" or "walls" are unrecognizable but on xix-xxii, on each side, just inside the median portion of *bc*, there is a clearly marked, slightly depressed, greyish translucent line with an appearance of a seminal groove, the line bent slightly mesially on the posterior half of xix and the anterior half of xxii so that the setal arcs of those segments are not quite reached (14).

Internal anatomy.—Septa apparently are lacking anterior to 5/6 (note location of nephridia of ii-v), 5/6 transparent and attached to the gut just in front of the gizzard; 6/7–9/10 funnel shaped, apices posteriorly; 9/10 displaced posteriorly and attached to the parietes directly over site of intersegmental furrow 10/11; 10/11-13/14 very delicate and displaced posteriorly.

The gizzard is in vi (14). Calciferous sacs are flattened, leaf-shaped bodies in vii-ix (14), the ducts passing to the gut dorsolaterally just in front of the septae. Intestinal origin probably in xiv or xv. The typhlosole begins abruptly in the region of xxv and is a simple lamella but with the height (2 mm.+) greater than the diameter of the gut so that the lamella is folded. The typhlosole ends abruptly 15–20 mm. from the hind end.

The dorsal blood vessel (single) is continued anteriorly to the pharyngeal region, deeply constricted behind 9/10 in such a way as to mark off eight to ten spheroidal sections, this portion of the trunk bent into an S-shaped figure and thus adding to the difficulties involved in determination of septal relationships. A supra-oesophageal trunk is recognizable only in x-xii or xiii. Extra-oesophageals are large in vi and filled with blood but elsewhere are empty, apparently passing ventrally on the anterior face of 5/6 and then turning mesially to unite under the gut. What appear to be posterior continuations of the trunks are close to or on the gut from vii posteriorly, in the region of ix-xiii at least, represented only by a median vessel on the ventral face of the gut. The subneural trunk is larger than the ventral vessel and looped with closed ends of the loops projecting out beyond the nerve cord. A pair of large branches in xii pass upwards to the supra-oesophageal but the trunk is continued anteriorly at least to 9/10. One or two other pairs of large vessels from the subneural have not been traced. In xii-xiii (?) four large vessels, apparently from the united extra-oesophageals, pass up from the gut to the supra-oesophageal. There are two pairs of hearts posterior to 9/10 (14) presumably of x-xi, all of which open into the supra-oesophageal. Connections to the dorsal trunk not found.

From x forwards nephridia are on the anterior faces of the septa, nephridia of iii-v on the anterior face of 5/6 but identifiable by the ducts which pass forwards and into the body wall at the usual positions in iii-v. Nephridia of ii are represented apparently by a large cluster of tubules on each side filling the space in front of 5/6 between the gut and the body wall. In each cluster is a large duct with two long, hairpin loops, which then passes anteriorly close to the ventral parietes and about in region of ii upwards into the gut. Nephridial funnels in the postclitellar segments are preseptal, close to the ventral parietes median to *a*, markedly scoop-shaped, the back of the scoop continued into two prongs. Anteriorly funnels have not been found.

Testes and male funnels are in two fairly widely separated and longitudinally directed, suboesophageal testis sacs so placed that the ovaries are just beneath the posterior ends. The hearts of xi apparently are included within the testis sacs which are filled or nearly filled (when small amounts of coagulum are present) by large, accordion-pleated frills (peripheral portions of male funnels?). On the floor and at the center of the sac is a rounded, button-like structure with a central depression which is probably the aperture of the funnel. From a point just in front of this aperture the male deferent duct drops to the parietes and then passes laterally for a short distance before turning to run posteriorly in the median part of *bc*, visible as far back as xvi or xvii before passing out of sight in the parietes.

The ovaries are unusually small. The oviducal funnels are flattened and very thin discs rather high up on the anterior face of 13/14, the oviducts unusually long but passing straight anteroventrally along the septum to the parietes.

Remarks.—In spite of the ubiquity of this species in the tropics and the frequent reports of its occurrence several questions as to gross morphology are still unanswered. The major difficulty is that of determination of segmental location of structures and this is due in part to the apparent absence of the first intersegmental furrow, the small size of the setae on the first setigerous segment, the dislocation posteriorly of certain septa, the small size and concealed location of the ovaries. The location of septum 9/10 over site of intersegmental furrow 10/11 is at first confusing but inspection of the inner surface of the parietes reveals quite clearly two segments between the parietal attachments of the last muscular septum and of the septum next in front. This presumably is the explanation for Stephenson's failure to find 9/10 (1923, p. 490). However in front of the last muscular septum there is only one pair of nephridia and one pair of vascular commissures while the attachments to the gut of the last calciferous sacs, supposedly of ix, are just in front of the last muscular septum, conditions which arouse a suspicion that 9/10 is not lacking but merely displaced posteriorly. The suspicion is strengthened on tracing the ducts of the nephridia, for each duct after dropping to the ventral parietes passes across *two* segments almost to 8/9. The final confirmation of the dislocation of 9/10 is provided by the ducts of the nephridia next behind the last muscular septum, the ducts passing on the parietes and underneath 9/10 and onwards under very delicate connective tissue to points just behind the site of intersegmental furrow 9/10. According to Michaelsen (1900, p. 425) 10/11 is thickened but in each of the Manila specimens that septum is just as tenuous and transparent as those next behind.

Oviducts were noted in one specimen only and in that worm were large enough so that they could be dissected out from the body wall. Only then were the female pores recognizable. The location on 14/15 is unusual and may be an abnormality.

(The use of "apparently," or similar phraseology, in the account above is regretted but the word concisely characterizes appearances, and nothing further is justifiable in view of the condition.)

Septal relationships as regards segments x-xv, the segment of intestinal origin, some of the relationships of the major blood vessels and the location of the female pores need confirmation or more accurate characterization.

Genus SPARGANOPHILUS Benham 1892

Sparganophilus eiseni Smith 1895

Material examined.—Roadside ditch, Yellow Fern Creek, Fort Myers, Florida, January 21, 1941, 11 aclitellate specimens. Prof. W. M. Barrows.

Roadside ditch, Fort Myers, Florida, February 19, 1941, 11 aclitellate and 3 clitellate specimens. Prof. W. M. Barrows.

External characteristics.—Length 80–85 mm. (clitellate specimens). Diameter 1½ mm. in clitellar region, 1¼ mm. elsewhere. Unpigmented. Anterior ends not hooked. Prostomium zygolobous (20) No dorsal pores recognizable but a longitudinal grey streak along the mid-dorsal line crosses i-iii to 3/4 or slightly onto iv, the streak slightly widened at intersegmental furrows and there with an appearance somewhat like that of rudimentary dorsal pores. Setae begin on ii, dorsal couples lacking on xvi-xxiv (3 clitellate and 6 aclitellate specimens), in part lacking or unrecognizable on the same segments of several other specimens. Behind the clitellum *ab* is slightly smaller than *cd*, *dd* and *bc* about equal and both larger than *aa*. Nephropores are invisible but sites are indicated by tiny, white, circular spots on or slightly lateral to *a*, about midway between intersegmental furrows and setal arcs.

The clitellum is rather grey, saddle-shaped, lacking in *bb*, anterior and posterior limits unrecognizable externally, xvi-xxiv included (3) and part at least of xv (1) and xxv (2) or xxv-xxvi (1) as indicated by the epidermal thickening at the mid-dorsal incision. The clitellar region is protuberant especially so at xix-xxi. Tubercula pubertatis are represented by longitudinal white bands (not protuberant) extending from or just behind the setal arc of xviii to 23/24 in the median half of *bc*, the margins, especially the lateral, sinuous (3).

The spermathecal pores are on 6/7–8/9 on *c* (3), the left pore of 8/9 quite definitely below *c* on one specimen. Female pores are on xiv, on or just lateral to *a* and about midway between 13/14 and the setal arc. Male pores are unrecognizable Apertures of the prostate-like glands are minute, on the ventral faces of tiny, nearly spheroidal, whitish protuberances located slightly posterolateral to the *b* setae of xvi-xvii and xxiv-xxvii (3 clitellate and several aclitellate specimens). On two of the clitellate specimens a circular area including the right *a* seta of ix is slightly tumescent but the only pore recognizable is the aperture of the setal follicle.

Internal anatomy.—No gizzard. An oesophageal valve is unrecognizable, the intestine apparently beginning with 8/9 or posteriorly in viii. No typhlosole.

The dorsal blood vessel (single) is continued anteriorly into ii, with moniliform hearts in vii-xi (7) and slender commissures in iii-vi. No subneural. Lateroparietal trunks are recognizable in vi-xiv, turning mesially just in front of 14/15, uniting on the upper surface of the ventral trunk and then disappearing from view (3, opening into ventral trunk?). On the parietes in xii-xiv just lateral to each lateroparietal trunk is a smaller vessel which turns upwards on the anterior face of 14/15 to open into the dorsal trunk.

Nephridia are present in xiii (14), lacking in xiv (14), present from xv posteriorly, the preseptal funnels close to the ventral parietes in *ab*.

Seminal vesicles of xi and xii are acinous with scattered brown flecks. The prostate-like glands of xxiv-xxvii are shortly and regularly looped in a rather zigzagged manner, the ducts straight, slender and with slight (muscular?) sheen. Glands in xvi-xvii usually are not looped but are arced. The gland of ix (right side only, two clitellate specimens) is fairly large and of irregular shape.

Remarks.—Spermathecae, present only in the clitellate specimens, appear to be juvenile, ampullae slightly developed in one worm only. There is no iridescence on male funnels or in the deferent ducts. Seminal vesicles and ovisacs are of about the same size and appearance in the clitellate and larger aclitellate specimens. In one of the clitellate worms the free extremity of one ovary passes through an aperture in 13/14 into the ovisac of the same side.

According to Hague (1923, p. 22) the prostate-like glands of *eiseni* usually open to the exterior through the follicles of the *b* setae, while in *benhami* Eisen 1896, according to Eisen, the apertures are anterior to *ab*. In the Fort Myers worms the pores are invariably posterolateral to *b*.

Hague has suppressed *benhami* with varieties *guatemalensis* and *carnea*. Possibly the taxonomy of the Sparganophilids of the United States requires reconsideration.

Family LUMBRICIDAE

Genus EISENIA Malmgren 1877

Eisenia foetida (Savigny) 1826

Material examined.—New Orleans, Louisiana, December 15, 1940, 2 clitellate specimens. E Liebman.

Campus, Johns Hopkins University, October, 1940, 4 clitellate specimens. Per Prof. S. O. Mast.

November, 1940, 2 aclitellate and 16 clitellate specimens (history unknown). Prof. W. M. Barrows.

Ohio division, California Earthworm Farms, Worthington, Ohio, January 10, 1941, 3 partially clitellate and 24 clitellate specimens. Per E. Gordon.

"Soilution earthworms," purchased from California Earthworm Farms, Los Angeles, California, December 30, 1940, 27 juvenile or aclitellate (and in part postsexual) and 42 clitellate specimens. Per E. Hoffman.

External characteristics.—The Johns Hopkins worms are small, 27-30 mm. long, though apparently complete and fully grown. The "soilution" worms may attain a length of 60 mm. and a diameter of five mm. Except under the highest powers of the binocular, the Johns Hopkins worms appear to be characterized by a uniform, dark red pigmentation without striping. Only 13 of the "soilution" worms have a conspicuous striping, on the other specimens the striping faint or quite unrecognizable. The prostomium is epilobous, *ca.* ½, a transverse furrow at the posterior end of the tongue usually lacking or if present slight and rather irregular. The first dorsal pore is on 4/5 (48), on 5/6 but with a definitely pore-like and possibly functional marking on 4/5 (3). Nephropores usually are unrecognizable but on several specimens pore-like markings are visible on xv and xvi halfway between *b* and mid *bc*.

The female pore is minute, on the setal arc of xiv, just lateral to *b*. The male pore is minute, on the setal arc of xv, about midway between *b* and *c*, often at the lateral end of a fairly deep, transverse slit with tumescent borders. Spermathecal pores are smaller than the male and female pores, on 9/10 and 10/11, slightly lateral to the mid-dorsal line. Pores may be symmetrically or asymmetrically placed with reference to the mid-dorsal line. If symmetrical, apertures of either pair may be slightly more widely separated than those of the other pair.

Clitellar margins (anterior, posterior and ventral) are often rather indistinct. Slight clitellar thickening of the epidermis anteriorly and posteriorly beyond the apparent (external) limits may be recognizable at the middorsal incision. The clitellum is located as follows: on xxv-xxxi (1), xxv-xxxii (1), xxvi-xxxi (9), xxvi-xxxii (52), xxvi-xxxii but reaching slightly onto xxv (1), xxvi-xxxii but reaching slightly onto xxxiii (3), xxvii-xxxii (4), xxvii-xxxiv (1).

Tubercula pubertatis are rather indistinct and boundaries are often difficult of recognition. Usually the tubercula appear to be of a rather narrowly elliptical outline and are longitudinally placed in the median half of *bc* with the median margins slightly lateral to *b*. A central portion, also of elliptical outline, is slightly more translucent than the rather wide, slightly tumescent and opaque, marginal portion. Tubercula pubertatis are located as follows: xxvii-xxx (1), xxviii-xxx (48), xxviii (postsetal half) -xxxi (presetal half)—23, xxviii (postsetal half) -xxxii (presetal half)—1, xxix-xxxi (3).

A variable number of the ventral setae in the clitellar region, and occasionally on one or two segments just in front of the clitellum, appear to be located each within an area of greyish translucence. Under highest powers of the binocular there is clearly recognizable just behind each of such setae a small, transversely placed, translucent marking of spindle or crescent shape. On such a marking there may be recognizable a single, minute spot with an appearance of a pore. If setae are carefully pulled out of the body wall from the interior after opening the worm, the anterior location of the aperture of the setal follicle, quite definitely in front of the marking, is clearly recognizable.

Local areas of tumescence extending across the whole of certain segments may have somewhat of an appearance of genital markings but never seem to be sharply demarcated. These areas are most commonly present on ix-xii in region of *cd* but have been noted on ix (2), xxi (2), xxii (1), or xxiii (2), in *ab*. An area around the male pore and in a median portion of *bc* is usually more or less markedly tumescent but the swelling may be entirely lacking on fully clitellate specimens with spermatozoal iridescence in the spermathecal ampullae.

Flattened discs are occasionally adherent to the body in intersegmental grooves: 20/21, in *bc* (1); 21/22, in *aa* (2), in *ab* (2), in *bc* (4); 22/23, in *aa* (1), in *bc* (4); 23/24, in *aa* (2), in *bc* (1); 24/25, in *aa* (1), in *bc* (1). The outline of the disc approximates to circular or pear-shaped. The peripheral portion is transparent, a central mass opaque and with an appearance of closely packed fibrils.

Internal anatomy.—There are no sacs on the oesophagus in x (20). Calciferous glands are in xi-xii. On each side of the oesophagus in xii there is a vertically placed, rather shortly hemi-ellipsoidal, white swelling, the white appearance due to presence in the calciferous glands of considerable masses of fine granules. The intestine begins in xv (20). The gizzard is located in xvii-xviii (20). The wall of the gut in xix is usually whitened and similar in superficial appearance to the gizzard.

The simple, lamellar typhlosole which begins gradually in the region of xx-xxiii, does not attain full height for several segments and ends abruptly, in lxxxix (worm of 100 segments), xcii (worm with 103 segments), or ciii (specimen with 117 segments). The lumen is vertically slit-like in cross section. In one or more small regions or along a considerable portion the ventral margin may be slightly furrowed longitudinally so that the typhlosolar lumen is rather Y-shaped (inverted) in cross section.

Five pairs of lateral hearts are present in vii-xi (20). In xii, opening into the dorsal trunk, there are two pairs of vessels which may be large, the posterior vessels resembling hearts but closely applied to the gut and gradually disappearing from view ventrally. A subneural trunk is present (20).

Seminal vesicles are four pairs, in ix-xii (20), those in ix-x usually about half the size of the others. Segments x-xi are usually filled with a testicular coagulum.

Spermathecal ampullae are usually in ix and x (19). In one specimen an ampulla is sharply constricted by 10/11, with one half each in x and xi. In another worm the left anterior ampulla is in x. One spermatheca is completely bifurcated entally, each ampulla containing a mass of spermatozoa.

Corresponding to each of the small, postsetal genital markings and closely associated with a setal follicle there is protuberant into the coelomic cavity from the parietes a soft gland so fragile that it usually fragments on manipulation, releasing a flocculent coagulum.

Remarks.—In one worm each seminal vesicle of ix-xii contains masses of brownish material similar to that forming the discs often present in the coelomic cavities. Another specimen has brownish material in the vesicles of xi and xii and several brown bodies or discs free in the coelomic cavity of xi.

Eisenia veneta (Rosa) 1896

F. hortensis Michaelsen 1890

Material examined.—"Found in toilet bowl," Cleveland, Ohio, April, 1941, 1 clitellate specimen. E. R. Miller per Prof. W. M. Barrows.

External characteristics.—Length 23 mm. Diameter 3 mm. Dorsum reddish anterior to clitellum. Behind the clitellum the body is markedly flattened dorsoventrally. Prostomium apparently prolobous but this appearance may be due to local contraction at the region of junction of prostomium and i. The first dorsal pore is on 5/6. Setae begin on ii, behind the clitellum *ab* and *cd* about equal though rather widely separated, $bc < aa$, $dd < \frac{1}{2}C$.

The protuberant clitellum extends from 26/27 to 32/33 laterally but dorsally xxxiii is included (*dd* only), the anterior and posterior limits sharply marked, the ventral boundary hardly recognizable. Tubercula pubertatis are on xxx-xxxi and the presetal portion of xxxii, well within median half of *bc* and reaching slightly into *ab* with *b* included and near the median margin, sharply demarcated, protuberant—especially so laterally, the margins slightly incised at 30/31 and perhaps indicating a double origin.

Spermathecal pores are on 9/10 and 10/11, slightly lateral to the mid-dorsal line. Female pores are on the setal arc of xiv slightly lateral to *b*. Male pores are in transversely slit-like depressions on the setal arc of xv and are quite definitely nearer to *b* than to *c*.

Internal anatomy.—The oesophagus is widened abruptly in the posterior portion of x but no sacs are recognizable. Longitudinal lamellae in xi-xiii are covered over mesially by a delicate and transparent film possibly representing the median wall of calciferous glands. The intestine begins in xv. The gizzard is in xvii-xviii. The typhlosole which begins in xx is low and of the simple, lamellar type. Last hearts in xi.

Male funnels are large, reaching to the level of the dorsal surface of the gut, and with a brilliant spermatozoal iridescence In addition to the usual seminal vesicles in xi and xii there is a single, smaller vesicle in ix on the left side. Spermathecae are in ix and x, the ampullae filled with iridescent material, slender ducts and ampullae of about the same length

Protuberant into the coelomic cavities from the parietes over the tubercula pubertatis are glandular masses just median to which are hypertrophied follicles of the *b* setae of xxx and xxxi. The setae are nearly straight, without nodulus, the extreme ental end portions slightly curved, the tips sharply pointed, an ectal portion grooved. No ornamentation.

Remarks.—The gut is somewhat macerated. In the intestine among the soil particles is a well rounded, almost spheroidal bit of quartz just over one mm. in diameter

E. veneta is a European form and has been recorded but twice before from North America: San Francisco and Urbana, Illinois. Smith (1924, p. 26) found it in large numbers in banks of streams and it is presumably from some such habitat that the Cleveland specimen got into the water supply

Genus BIMASTOS Moore 1893

Bimastos tenuis (Eisen) 1874

Material examined.—Sand pasture, Manitoulin Island, Ontario, August 13, 1940, 1 aclitellate and 2 clitellate specimens. C. H. Kennedy per Prof. R. C. Osburn.

External characteristics.—Length 20-27 mm. Diameter across clitellum, three mm. The dorsum anterior to the clitellum is red. Setae *a* and *b* of xvi are enlarged, the follicles conspicuously protuberant into the coelomic cavity just behind a glandular mass. All of the setae examined, except one, are sigmoid but with the nodulus about one third the distance of the shaft from the ental end. The exceptional seta is almost straight, no ornamentation recognizable.

Spermathecal apertures are minute openings on 9/10, on *c*. The female pores are very slightly posterolateral to *b*. Each male pore is within and close to the lateral margin of a transversely placed, slit-like depression located in an area of tumescence. A transversely placed area on xv and xvi just lateral to *b* is swollen and whitened but without distinct demarcation.

Tubercula pubertatis are small, slightly tumescent, whitened areas of approximately circular outline, with centers about on the *b* line and reaching slightly into *ab*, the *b* setae of xxix and xxx very slightly displaced mesially.

Internal anatomy.—Calciferous pouches are vertically ellipsoidal bodies in the posterior portion of x, clearly marked off from the gut but without stalks, opening into the gut through vertically slit-like apertures the margins of which are in apposition. A low typhlosole is present.

The male deferent ducts of a side pass laterally to the region of *c* and come into contact in xii, passing posteriorly on the parietes to the anterolateral corner of a flat glandular mass with a longitudinally rectangular outline, sessile on the parietes in xiv-xvi, in a median portion of *bc*. Other glandular masses of approximately circular outline are sessile on the parietes over the tubercula pubertatis.

Spermathecae have a spheroidal ampulla and a slender duct with the length about equal to the diameter of the ampula.

Remarks.—Specimens are too soft to permit determination of typhlosolar characteristics. Calciferous sacs of x are filled with clumps of white granules. Because of the stickiness of the glandular material the course of the male deferent ducts has not been completely traced but it appears to be posteromesially within the gland. Ducts are slightly iridescent, fairly large, on rather than within the parietes and hence easy to trace. Removal of nephridia is necessary for observation of the genital marking glands and enlarged setal follicles. One specimen has a single spermatheca on the left side, another worm has a pair.

A non-sexual worm collected along the Chesapeake and Ohio Canal near the District of Columbia line by Slatin and forwarded by the U. S. National Museum may be *tenuis*. There are only two pairs of seminal vesicles and spermathecae are lacking. The region of xxvi-xxxi is contracted in a regularly concave fashion and has an appearance like that of a clitellar region towards the end of clitellar regression. The digestive system is macerated, the oesophageal wall practically transparent. In xi-xiii there are clearly recognizable, without opening the gut, two series of thin but rather conspicuous lamellae. Each lamella of the first series is longitudinally rectangular in shape, extending through xi-xii without constriction. Lamellae of the second series are almost square and in xiii, separated from the anterior series by an interval in which lamella are quite lacking. Lamellae are discrete and without evidence of marginal fusion internally (*i. e.*, towards center of gut). This condition (of discrete lamellae) presumably is a result of maceration.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIII MAY, 1943 No. 3

ON SOME AMERICAN AND ORIENTAL EARTHWORMS

PART II. FAMILY MEGASCOLECIDAE

G. E. GATES[1]
Judson College, Rangoon Burma,
and
The Ohio State University, Columbus, Ohio

Part I of this article contains descriptions and notes on distributions of earthworms of the families *Moniligastridae*, *Glossoscolecidae* and *Lumbricidae*, sent recently to the Zoology Department of The Ohio State University for identification. Included among this material is the first specimen of the large Indian earthworm, *Drawida grandis* (Bourne) 1886, that has been available for study since the species was first described.

Part II contains descriptions and notes on similar material belonging to the family *Megascolecidae*.

Family MEGASCOLECIDAE

Genus PONTODRILUS E. Perrier, 1874

Pontodrilus bermudensis Beddard 1891

Material examined.—Under sea weed on beach, St. Croix, Virgin Islands, March, 1938, 5 aclitellate specimens. H. A. Beatty per U. S. Nat. Mus.

External characteristics.—Length to 55 mm. Diameter to 2 mm. Prostomium slightly epilobous. Setae: posterior to xx *aa*, *bc* and *cd* are about equal or *bc* may be smaller than *cd*, *ab*<*cd*, *dd*<½C. Nephropores are not certainly recognizable but appear to be on *c*. No dorsal pores.

Spermathecal pores are minute, on 7/8 and 8/9, on or just lateral to *b*. Female pores are on xiv anteromedian to *a* and slightly nearer to 13/14 than the setal arc. Male pores are minute, on xviii, on the setal arc and about on *b*. A grey spot on the setal arc of xviii on *a* appears to mark former site of an aperture into a setal follicle.

Segment xviii is anteroposteriorly elongated ventrally and especially so in a region extending from just median to *a* nearly to *c* on each side. Approximately in *ab* on each side of xviii is a longitudinally placed area of greyish translucence, rather sharply demarcated but with sinuous margins. Each area is indented mesially and laterally by a white, rather conical, undemarcated protuberance, the lateral especially conspicuous, the protuberances reaching highest elevation on the setal arc.

The single genital marking (5) is on 19/20, reaching laterally on each side about half way to *a*, with central translucent and marginal opaque portions demarcated on the larger specimens.

Internal anatomy.—There is a rudimentary gizzard in v (3, not noted in other two specimens). Calciferous glands and lamellae are lacking but the oesophageal wall is thickest and most vascularized in xiv–xv. The intestine begins anteriorly in xvii (3), the oesophageal valve in the region of attachment of septum 16/17. No typhlosole.

---

[1] Visiting professor in the Department of Zoology and Entomology of the Ohio State University, 1940-41.

The dorsal blood vessel (single) is continued anteriorly onto the pharyngeal bulb. A supra-oesophageal trunk is unrecognizable. Extra-oesophageals are large, close to the ventral parietes in i–v, much more dorsal posteriorly, passing onto the gut in xii–xiii, uniting mesially in xiv or xv. No subneural trunk (3). Last hearts in xiii (5).

Nephridia of xiii are small (5), no nephridia in xiv or anteriorly, larger nephridia present from xv posteriorly (5). The preseptal funnels are close to the ventral parietes in *ab*.

Holandric, acinous seminal vesicles present in xi and xii (5). The prostatic duct is curved into a sigmoid or C-shape, one to two mm. long and nearly as long as the gland, with marked muscular sheen. On the median faces of the prostatic ducts within the parietes are very small setal follicles. The vasa deferentia were not traced as they are not certainly recognizable posterior to xi.

The spermathecal duct is about as long as or longer than the ampulla from which it is fairly sharply marked off, adherent (by the posterior face) to or imbedded in the parietes back to the level of the setal arcs of viii and ix. The digitiform diverticulum passes to the median face of the duct within the parietes and is long enough to reach up slightly onto the ampulla.

The epidermis of the genital marking on 19/20 is markedly thickened. White material within the body wall under each protuberance on xviii may be glandular.

Remarks.—The intestine of each specimen is largely filled with coral fragments including some that are as much as 1½ mm. long. Also included is a disc of approximately circular outline and with a diameter of one mm. Bits of coral of appropriate size and disposition in the oesophagus may produce an appearance of the presence of gizzards or of calciferous glands. A bit of yellowish, calcareous tube of approximately segmental length and completely filling the gut in vii produced an appearance practically indistinguishable from that of a gizzard until the gut was opened. The oesophagus in v is widened, the shape approximating to that of a gizzard and the wall is definitely thicker than in iv or vi.

In the spermathecal ampullae of the larger specimens there is brownish material which may indicate that such individuals are in a postsexual stage after completion of clitellar regression.

The worms described above appear to be referable to *P. bermudensis* as now understood but the species is variable and Michaelsen (1909) recognized a number of *formae*, the taxonomic status of some of which must be regarded as doubtful.

Pontodrilus gracilis sp. nov.

Material examined.—Edge of Caloosahatchie River (brackish), Fort Myers, Florida, January 23, 1941, 21 aclitellate specimens. Prof. W. M. Barrows. Caloosahatchie River, Fort Myers, Florida, February 19, 1941, 15 aclitellate specimens. Prof. W. M. Barrows.

External characteristics.—Length to 170 mm. Diameter to 2½ mm. Unpigmented. Prostomium epilobous, *ca.* ½, but with no transverse furrow at posterior end of tongue (20). No dorsal pores. Nephropores are on *b*, presetal, about one quarter of the distance from intersegmental furrows towards the setal arcs, the pores of xviii, often slightly enlarged, just lateral to the genital markings. Setae begin on ii but may be lacking in part on ii–vi, near the hind end the dorsal ranks quite irregular, the lateral setae fairly closely or widely paired or widely separated; on xx, *cd* slightly larger than 2*ab*, *bc*, *cd*, and *aa* about equal, *dd*> 2*cd*.

Quadrithecal, spermathecal pores minute and superficial, each pore at center of a small, almost circular protuberance, in *ab* and usually on or near mid *ab* (never on *a* or *b*), the intersegmental furrows lacking on the porophores. Female pores are on xiv, median to *a*, about halfway between 13/14 and the setal arc.

Male pores are minute and superficial, on xviii, on or close to sites of *b* setae, the apertures larger than those of setal follicles or of the female ducts but so recognizable only after removal of cuticle, each pore on a small, rounded or conical protuberance which may be surrounded by a marginal band of greyish translucence. On the most mature worms the porophores are located in the lateralmost portions of a deep, transversely placed depression. Seta *a* of xviii is present on one side or the other of six specimens, on both sides of one specimen, otherwise ventral setae are unrecognizable.

Genital markings are one pair of presetal areas in *ab* on xviii (36). In the less mature specimens the markings are circular, sharply demarcated and each is surrounded by a marginal band of greyish translucence which is continuous with that around the male porophore. On more mature worms markings are elliptical in outline and longitudinally placed, 17/18 unrecognizable ventrally and some slight invasion of xvii possible. On three worms a slightly protuberant genital shield without definite demarcation extends from the setal arc of xvii at least to 18/19 and laterally to *c*. On these specimens as well as several others xviii is elongated ventrally and markedly widened. The genital markings indicate areas of marked parietal modification. Unpaired, median or other genital markings are lacking.

Internal anatomy.—Septa are present from 4/5; 5/6–12/13 muscular, 4/5 slightly muscular, 13/14 strengthened but translucent.

The oesophagus in iv–x is brown and provided internally with low, white, longitudinal ridges; perhaps slightly widened in v but with no gizzard. In xi–xiii the oesophagus is slender and white, widened abruptly just behind 13/14 (36), the portion in xiii with an appearance of an oesophageal valve. From xiv–xviii however the gut is highly vascular, vertical red stripes especially conspicuous on the coelomic surface of the portion in xiv–xvi, the inner wall with numerous, closely crowded, low, longitudinal, white ridges which become less obvious in xvii–xviii. In xviii quite definitely in front of 18/19 (11) or in xix at various distances from 18/19 (10) the gut is again abruptly widened, though not as conspicuously as at 13/14, and the appearance of both inner and outer walls changes slightly. A definite valve in this region is unrecognizable. The inner wall of the intestine is marked off into small squares by slight longitudinal and circular furrows. No typhlosole.

The dorsal blood vessel (single) is continued anteriorly to and under the supra-pharyngeal ganglia. A supra-oesophageal trunk is usually recognizable from xv to 11/12 but is usually empty anteriorly. Extra-oesophageals are first recognizable in v (anterior to 4/5 apparently continued dorsally and then anteriorly into ii), passing onto the ventral surface of the gut only in xiv or xv, united mesially in xv or xvi, usually unrecognizable behind xvii. A rather conspicuous branch passes laterally from each extra-oesophageal in x–xvi on the anterior faces of the septa. The ventral trunk is continued forwards to the anterior margin of the subpharyngeal ganglia where it bifurcates. No subneural. In x–xiii there are large latero-oesophageal hearts, the connectives with the dorsal trunk red and rather conspicuous, the slender, short branches to the supra-oesophageal usually white. The last pair of hearts is in xiii (35), the left heart of xiii lacking in one specimen. There are commissural loops in v–ix, all loops and hearts passing into the ventral trunk.

Nephridia in xiii are small, the funnels club-shaped (23, not noted in other specimens). There are no nephridia anterior to xiii or in xiv (23), the large nephridia always beginning in xv. The tubules are flattened against the body wall, reaching to or nearly to both septa of a segment and dorsally to *d*. The preseptal funnels are close to the ventral parietes in *ab*.

Testes, in x and xi, are rather fan-shaped. Male funnels are free, with smooth, rounded rims. Seminal vesicles in xi and xii are acinous, vertically placed. Prostates are usually confined to the posterior half of xviii, the nephridia in the anterior half. The ducts of the most mature specimens are slightly more than two mm. long, with marked muscular sheen, straight, sinuous, or slightly looped, but never spindle-shaped. The male deferent ducts pass into the ectal ends of the prostates. On the median face of the prostatic duct there is often visible a cord of tissue that looks like a setal follicle. In two worms setae appeared to be present in the follicles but attempts to dissect out the setae were failures.

The spermathecal duct is shorter than the ampulla, narrowed within the parietes, with large lumen. In fifteen specimens the single, digitiform diverticulum on each spermatheca passes into the median face of the duct close to the parietes. In five worms each spermatheca has a lateral diverticulum of the same size as the median and passing into the duct exactly opposite the median junction. A lateral diverticulum of the same size as the median is present in other specimens as follows: on both left spermathecae (2), on both right spermathecae (3), on the left posterior spermatheca (6), on the right anterior spermatheca (2), on both spermathecae of ix (1), on three spermathecae (1). In the remaining worm the median diverticula are about half the length of the main spermathecal axis while the lateral diverticula (lacking only on the right posterior spermatheca) are much shorter. In one worm with unidiverticulate spermathecae one diverticulum is bifid.

The longitudinal musculature is uninterrupted over sites of the genital markings.

Remarks.—Spermathecae of several worms from each batch, with and without lateral diverticula, have brownish masses in the ental ends of spermathecal ampullae and diverticula, possibly the last remaining evidences of post-sexual regression. The clitellar region shows no evidence of clitellar regression.

The specimens described above are distinguished from *bermudensis* as follows: (1) a slightly more median location of spermathecal pores, (2) presence of symmetrically paired, longitudinally placed, presetal genital markings on xviii, (3) absence of unpaired, intersegmental genital markings in *aa*, (4) junction of diverticulum with spermathecal duct ental to the parietes, (5) tendency to development of a second and lateral diverticulum on the spermathecal duct, and possibly also by (6) a more ventral location of the nephropores as well as (7) the irregularity of setal ranks in a posterior portion of the body. Such a combination of characteristics appears to be sufficient justification for recognition of a species distinct from *bermudensis* but it is to be remembered that *bermudensis* as now understood is highly variable, comprising a number of *formae* of uncertain status, and that the Florida specimens are aclitellate. Accordingly it is possible that certain characteristics of taxonomic importance may now be unrecognizable on the types of the new species. Nevertheless it appears to be unlikely that with sexual maturity any of the distinguishing characteristics just mentioned will approximate to those of *bermudensis* except for a development of unpaired, intersegmental genital markings-structures which may characterize more than one species of *Pontodrilus*. A satisfactory diagnosis cannot be given until clitellate specimens have been studied.

GENUS PHERETIMA Kinberg, 1867

Pheretima californica Kinberg 1867

Material examined.—New Orleans, Louisiana, August 13–15, 8 clitellate specimens. Southern Biological Supply Co., per U. S. Nat. Mus.

Remarks.—This is the first record of the species from United States since erection on specimens from San Francisco.

Pheretima diffringens (Baird) 1869

Material examined.—Lawn, Fort Myers, Florida, February 19, 1941. 1 clitellate specimen. Prof. W. M. Barrows.

External characteristics.—The first dorsal pore is on (10/11?) 11/12. Genital markings are presetal on vii–ix, midway between intersegmental furrows and setal circles, ca. 2–3 intersetal intervals median to the spermathecal pore lines. Spermathecal porophores are unrecognizable and postsetal markings are lacking.

Internal anatomy.—The intestine begins in xvi just behind 15/16. Hearts of x are lacking, the right heart of ix present. Lymph glands are rudimentary anterior to xxvii but posteriorly are well developed. Unpaired, suboesophageal testis sacs are well above the nerve cord, the ventral blood vessel included. Vasa deferentia of a side come into contact in xii but without uniting at least into xvii. Prostates are lacking but prostatic ducts are fairly well developed, each duct bent into a U-shaped loop. The stalks of the genital marking glands of xviii pass into the parietes just median to the prostatic ducts. The lumen of the spermathecal duct is narrowed in the region of the diverticular junction, slit-like in cross-section entally, more nearly circular ectally.

Remarks.—Seminal chambers of spermathecae are filled with opaque whitish material, testes are large and transversely ellipsoidal but there is no spermatozoal iridescence in seminal chambers, vasa deferentia or on the male funnels.

From information at present available, *diffringens* appears to be the most widely spread of those species imported into this country, directly or indirectly, from China and Japan, having been found from Louisiana to Virginia (no record from South Carolina).

Pheretima hawayana (Rosa) 1891

Material examined.—Greenhouses, Hadley, Massachusetts, January 1941, 3 clitellate specimens. Prof. Esther Carpenter.

Remarks.—The testis sacs are unpaired and suboesophageal, distended by coagluum, the ventral blood vessel on or within the roofs of the sacs, the nerve cord well below the sacs.

Pheretima pingi Stephenson 1925

Material examined.—Kuatun, Fukien Province, China, 3000–5000 feet, July, 1939, 1 clitellate specimen. Min Hsin Li.

External characteristics.—Length 240 mm. Diameter 9 mm. Pigmentation bluish grey, restricted to the dorsum, lacking or scarcely recognizable on transverse, midsegmental bands bearing the setae. First dorsal pore on 12/13. Setal formula: vi/9, vii/8, viii/14, xvii/18, xviii/16, xix/22, 22/ii, 23/iii, 38/viii, 41/xii, 48/xx.

Each spermathecal pore is at the center of a tiny circular, white, opaque area that indents the posterior margin of a transversely placed area of greyish translucence. The translucent areas are on the posterior portions of v–viii, the spermathecal pores about in line with the intersegmental furrows. Prior to removal of the cuticle the pores appeared to be segmental. Each male pore is at the center of a transversely placed porophore of elliptical outline.

Genital markings, aside from those just in front of the spermathecal pores, are on xviii, three pairs. One marking either indents deeply the lateral margin of each male porophore or is actually protuberant from the male porophore close to the lateral margin. Two other markings on each side, somewhat larger but smaller than the male porophores, are just median to the male pore lines, one presetal and one postsetal, the latter in contact with but distinct from the male porophore.

Internal anatomy.—Septum 8/9 is complete but membranous. The first lymph gland is in xvi, on the left side. From xix posteriorly a pair of large glands is present in each segment. Most of the glands have one or more balls of variable size of brownish, granular material within the gland tissues.

The dorsal blood vessel (single) is continued anteriorly underneath the supra-oesophageal ganglia. The supra-oesophageal trunk is unrecognizable posterior to 13/14 and disappears into the dorsal wall of the gut in ix. The ventral trunk bifurcates just behind the subpharyngeal ganglia, the branches passing laterally along with the circumoesophageal nervous commissures. Between the anterior bifurcations and the junctions of the commissures of v, two pairs of vessels join the ventral trunk, possibly commissures of iv and iii or their representatives. The subneural trunk is continued anteriorly a short distance in front of the subpharyngeal ganglia before bifurcating. The extra-oesophageal trunks pass onto the ventral face of the gut in ix and just in front of 13/14 pass off laterally. The left trunk passes into the subneural. All commissures of v–vii and the hearts of ix–xiii pass into the ventral trunk. Commissures of v–vii, a pair of large vessels from the gizzard and the hearts of ix open into the dorsal trunk. Hearts of x–xiii open into the supra-oesophageal. In addition each heart of x–xiii is connected to the dorsal trunk by a white cord, probably a blood vessel, but only those of x are red. A pair of hearts belonging to ix is present but the ventral half of the right heart is quite slender.

Testis sacs of x and xi are unpaired and suboesophageal. The ventral blood vessel is included in the sacs and is almost in contact with floors and roofs both. The nerve cord is well below both sacs. The prostatic duct is 2–3 mm. long.

The spermathecal duct (including the parietal portion) is slightly shorter than the ampulla from which it is sharply demarcated. The lumen of the duct is abruptly narrowed in the region of the diverticular junction. The diverticular stalk is nearly as long as the duct, the ellipsoidal seminal chamber about one quarter the length of the diverticulum. Just in front of each spermathecal duct and sessile on the parietes is a glandular mass. In xviii, on each side, there are three glandular masses, each mass at least partially imbedded in the parietes so that some dissection is necessary to discover the multiple nature of the glands and relationships to genital markings.

Remarks.—The specimen is in very good condition as is indicated by the preservation of the soft lymph glands. The hearts of ix are clearly behind and independent of the membranous postgizzard septum. The last two pairs of spermathecae are anterior to 8/9. In spite of apparent intersegmental location of the spermathecal pores the completeness of 8/9 presence of hearts in x and the genital markings necessitate identification as *pingi*. The relationships of *diffringens* (Baird) 1869 and *pingi* remain undetermined (*vide* Gates 1938).

Pheretima subtilis sp. nov.

Material examined.—Manured ground in low and damp Shan garden, Meung Nawng village, Salween ferry, Pang Long State, Burma, October, 1 clitellate specimen. H. Young.

External characteristics.—Length 60 mm. Diameter four mm. Unpigmented.

The setae begin on ii, on which segment there is a complete circle, and are small, closely crowded, present ventrally on each clitellar segment: vi/39, xvii/23, xviii/16, xix/24, 42/ii, 69iii, 86/viii, 76/xii, 16/xiv, 18/xv, 20/xvi, 76/xx.

The first dorsal pore appears to be on 11/12. The clitellum is annular, yellowish brown, and extends from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking.

Bithecal, spermathecal pores minute and superficial, on 5/6, widely separated. The female pore is median. Male pores are minute, each pore at or near the center of a small, transversely placed, glistening tubercle with rounded ventral face. The tubercle is slightly depressed and partially covered by a thin, lateral flap. The appearance is such as to suggest that the male pore tubercle is on the median wall of a slight parietal invagination with a thin lateral wall.

The genital markings are unpaired, median, transversely placed, slightly protuberant, intersegmental, on 22/23 and 23/24, extending anteroposteriorly almost to the setae, the midventral setae of xxii and xxiv slightly dislocated anteriorly or posteriorly. The anterior marking is about twelve intersetal intervals wide transversely and is slightly larger than the other marking.

Internal anatomy.—Septa 5/6–7/8 are slightly muscular; 8/9–9/10 lacking; 10/11–11/12 slightly muscular.

The intestine begins in xv. Intestinal caeca are simple, small, with smooth margins. There is a slight rudiment of a glandular collar on the oesophagus just behind the gizzard.

Hearts of x are lacking but a pair of hearts belonging to ix is present. Hearts of xi were not found. All hearts of ix, xii–xiii pass into the ventral blood vessel.

The testis sac of x is unpaired and ventral, the sac of xi unpaired and U-shaped, reaching up to the level of the dorsal face of the gut but not bound mesially to the gut. The seminal vesicles of xi are small, included within the testis sac and imbedded in testicular coagulum. Vesicles of xii are medium-sized. Prostates extend through xvii–xix. The prostatic duct is about 3½ mm. long, rather slender, bent into a U-shaped loop, the ectal limb slightly thickened.

The spermathecal duct is slender and somewhat shorter than the ampulla, gradually narrowed within the parietes, the wall rather thin and with annular ridges internally, the lumen abruptly narrowed in the region of the diverticular junction. The diverticulum which passes into the median face of the duct close to the parietes comprises a stalk and an elongately tubular seminal chamber only slightly longer and thicker than the stalk and with spermatozoal iridescence. Both stalk and seminal chamber are looped, the looping in part approximating to a regularly zigzagged arrangement. Because of the looping the diverticulum just reaches up onto the ectal portion of the ampulla.

Genital marking glands are sessile on the parietes.

Remarks.—Difficulty in characterization of the male externalia is due to softening and slight erosion. *P. subtilis* is distinguished from all other bithecal species with pores on 5/6 by the genital markings.

Diagnosis.—Bithecal, spermathecal pores minute and superficial, on 5/6, widely separated. Male pores minute (and invaginate?), each pore on a small tubercle (within a slight parietal invagination that has a thin wall?). Genital markings unpaired, median, transversely placed, on 22/23 and 23/24. Setae present ventrally on all clitellar segments: vi/39, xvii/23, xviii/16, xix/24, 42/ii, 69/iii, 86/viii, 76/xii, 76/xx. First dorsal pore on 11/12(?). Length 60 mm. Diameter 4 mm. Intestinal caeca simple. Hearts of x lacking. Testis sacs unpaired: of x ventral, of xi U-shaped; seminal vesicles of xi included. Spermathecal diverticulum passing into the median face of duct near parietes, looped, in part in a regularly zigzagged manner, stalk about as long as the slightly thicker, elongately tubular seminal chamber. Genital marking glands sessile.

Genus PLIONOGASTER Michaelsen, 1892

This interesting but inadequately characterized genus has been recorded only from the Philippines (four species) and the Moluccas (Ternate, one species) and is supposed (Stephenson 1930, p. 831) to have evolved from that "polyphletic" complex which must be referred to as *Megascolex* for the present. That complex is restricted to two separate areas, one including Ceylon and South India, the other including Australia (southwestern, southern, eastern and northeastern parts), Tasmania, New Caledonia and Norfolk Island.

Plionogaster sp.

Material examined.—Manila, Philippine Islands, October, three aclitellate specimens in fair condition. Zacharias de Jesus per Prof. R. C. Osburn.

External characteristics.—The largest specimen is 160 mm. long, with a diameter of nearly four mm. The other worms are much less than half as long. Unpigmented (3). The prostomium is rather indistinctly marked off but appears to be proepilobous (3).

Setae begin on ii (3) and are small, rather closely crowded, the setal circles with but slight midventral and mid-dorsal gaps, circles of v-x nearer anterior margins of the segments; xviii/19 (smallest specimen); *ca.* 90/xii, *ca.* 56 near the posterior end, viii/30, xvii/23, xviii/10, xix/18 (largest specimen).

Nephropores are first recognizable with some degree of certainty on x though possibly present also on ix, and are in three fairly regular longitudinal series on each side to xviii; one series about on the male pore lines, another about on the midlateral line, and the third nine to eleven intersetal intervals lateral to the mid-dorsal line. In each series the pores are in the setal circles. Toward the hind end the longitudinal ranks are more irregular, the dorsal rank three or more intersetal intervals lateral to the mid-dorsal line, the ventral rank about the same distances from the midventral line, pores of the lateral rank not always recognizable with certainty. The first dorsal pore is on 12/13 (3, but with a pore-like, possibly functional marking on 11/12 of one of the smaller worms).

Spermathecal pores are small, transversely placed slits on 7/8–8/9 (3). The anterior margin of each pore (largest specimen) is swollen, the tumescence with a transversely elliptical outline, sharply demarcated anteriorly by a short, transversely placed furrow. The single female pore is median, slightly presetal, on xiv, at the center of a small tumescence of transversely elliptical outline (1).

The male pores are slightly postsetal, transversely placed, small, crescentic slits (3). The anterior lip of each pore (largest specimen) is protuberant, the tumescence circular in outline, each pore and tumescence at the center of a small, transversely placed, whitened area of epidermal (?) thickening.

The two genital markings, just recognizable on the largest specimen, are of transversely elliptical outline, unpaired, extending laterally on each side about to the male pore lines, presetal on xx and xviii (but crossing slightly or dislocating anteriorly 17/18?). A central portion of each marking has a greyish translucent appearance. On the smallest specimen there is on each side, on xvii and close to 17/18, about in line with the male porephore, a circular area of greyish translucence, indistinctly demarcated, possibly a rudiment of a genital marking.

Internal anatomy.—All septa from 5/6 posteriorly are present; 5/6–9/10 muscular, 5/6–8/9 especially so.

The gut is rather slender and white in vi–ix, the portion in viii slightly widened, of spheroidal shape and with thickened cuticular lining (3). In x–xi the gut is more obviously vascularized and in xii–xviii is widened, with walls striated by red, circular bands. A definite valve is present in the anterior portion of xix but is entirely concealed from view by the anterior portion of the intestine which reaches forward into contact with 18/19 (3). The gizzards are three (2) or four (1), separated from each other by long, thin-walled but white intestinal annuli. The length of each gizzard or intervening annulus is much greater than that of a segment and accordingly this portion of the gut is markedly asymmetrical in each specimen. Segmental locations of the gizzards were not determined but the first gizzard appears to be in or shortly behind xxv. A quite rudimentary typhlosolar ridge is present from xix nearly to the first gizzard but does not become recognizable again until 16 or 17 segments behind the last gizzard, finally disappearing from sight in the region of lxii (1) or lxxxv at a point still in the anterior third of the body (1). Caeca and supra-intestinal glands are lacking.

The dorsal blood vessel (single) is continued anteriorly to the region of iii. The ventral blood vessel is unrecognizable anterior to vi. An unpaired supraoesophageal trunk is visible on the gut from ix into xviii. On the ventral face of the gut at the median line from the last gizzard segment into xix or xv is a vessel which is nearly as large as the ventral trunk, bifurcating in xv or xix, the two branches fairly widely separated from each other but adherent to the gut as far forwards as ix, ventrolateral to the gut in viii, unrecognizable from vii anteriorly. No subneural recognizable (3). In the two smaller specimens there are four pairs of large "hearts" in x–xiii, each pair probably communicating with the dorsal as well as the supraoesophageal trunks. In the other worm "hearts" are present in xii–xiii but commissural vessels of x–xi are much slenderer and white. Blood glands and lymph glands apparently are lacking.

Anterior to 5–6 and at each side of the gut there is a large mass of nephridial tubules, each mass falling apart into three sections with a little probing. In vi–ix, on the anterior face of each septum there is a pair of vertically elongated, anteroposteriorly flattened bands of nephridial tubules. From xii–xvii (x–xi?) four longitudinal series of fairly small, closed, parietal micronephridia are present on each side, a slender duct passing laterally from each nephridium to a longitudinally placed vesicle or bladder which is adherent to the parietes (largest specimen). Posteriorly only three ranks of parietal micronephridia are certainly recognizable on each side and bladders were not found. Beginning with xviii, at least, there is in each segment a pair of meganephridia which reach well towards the mid-dorsal line on the parietes just behind the septa. Slightly lateral to the nerve cord on each side and near the ventral parietes is a preseptal funnel. The neck is very slender and has not been traced with certainty to the nephridial tubule. The duct is also very slender and passes onto the posterior face of the septum where it runs dorsally nearly to the margin of the dorsal blood vessel. Passing posteriorly the size of the meganephridia markedly decreases but preseptal funnels are still recognizable almost at the posterior end. On the dorsal face of the gut from a region behind the last gizzard to the hind end and in contact with the lateral face of the wide and flattened dorsal blood vessel there is on each side a translucent tube, the two tubes with occasional transverse connectives. Lacking blood these tubes should be longitudinal excretory ducts and very delicate whitish threads representing the segmental ducts of the meganephridia, in some segments at least, do pass to the excretory tubes.

Testis sacs of x and xi are of the cylindrical type and contain in addition to testes and male funnels the hearts or commissures and the seminal vesicles of xi. The sacs of the largest specimen are filled with coagulum. Seminal vesicles are also present in xii. Prostates are racemose and confined to xviii. The duct is straight, with muscular sheen, thicker ectally, about one mm. long. In the largest specimen a filament, probably the male duct, rises from the parietes median to the duct and passes into the entalmost portion of the duct. The lumen of the duct is slit-like in cross section.

The spermathecal duct (longest specimen) is shorter than the ampulla and nearly as thick. The diverticulum, usually shorter than combined lengths of duct and ampulla, is rather slenderly club-shaped and passes into the duct close to the parietes. The diverticular lumen is large with numerous thin but relatively rather high annular (? or spiral) ridges on the inner wall of the diverticulum. In one of the smaller specimens the spermathecal diverticula are about as long as the main spermathecal axes.

Remarks.—The number of intestinal gizzards, shape of the spermathecal diverticulum, symmetry and location of genital markings and number of longitudinal ranks of micronephridia are the characteristics hitherto used for specific diagnosis and identification in the genus *Plionogaster*. So little material has been available for study that the value of these characteristics is uncertain. Number of gizzards may be variable as in the Moniligastridae. A tubular diverticulum may be distended entally by spermatozoa after copulation so as to be more or less club-shaped. Genital markings may be variable or unrecognizable except at full maturity. The taxonomic value of numbers of micronephridia is unknown and in any case such characteristics must be used with considerable caution in view of the difficulty in recognition of nephropores, the fragility of the nephridia and the occasional fragmentation or even complete disintegration of tubules (perhaps partly as a result of handling during examination of externalia) in specimens that otherwise appear to be very well preserved.

P. horsti (Beddard) 1886 and *P. sivickisi* Stephenson 1933, the two species hitherto recorded from Manila, apparently are distinguished from each other mainly by the genital markings, paired or lacking in *sivickisi*, both paired and unpaired in *horsti*. From those species the present worms may be distinguished by the presence of unpaired genital markings alone. If however there is no intra-specific variation as to number of gizzards, two species are represented in the new material. *P. jagori* Michaelsen 1892, the species supposedly characterized by four intestinal gizzards has paired genital markings only.

Definition of the genus merely as micronephridial (Michaelsen 1900 and Stephenson 1930) is obviously incorrect. In view of the condition of the specimens and the limited material available an accurate diagnosis is still impossible but the following is suggested tentatively: Quadrithecal, spermathecal pores on 7/8–8/9. Female pore median, on xiv. Male pores on xviii. Setae perichaetine. Clitellum annular (?), on xiv–xvi (?, dorsal pores, intersegmental furrows and setae?). Nephropores in setal circles, in three to six (?) longitudinal ranks from ix posteriorly. Unpigmented. All septa from 5/6 present. Gizzards three or four in a region of the intestine from xxv posteriorly, a regressive oesophageal gizzard in viii; intestinal origin in xix, typhlosole rudimentary, interrupted in gizzard region; no calciferous glands. Hearts lateroesophageal in (x–xi)–xiii; extra-oesophageals pass onto ventral face of gut in ix, unite midventrally in xv–xix, the united trunks continued posteriorly into gizzard region; no subneural. Excretory organs: one pair of open, enteronephric meganephridia with preseptal funnels from xviii posteriorly, opening into paired and fairly widely separated, supraintestinal ducts with transverse connectives; three to six (?) irregularly longitudinal ranks of closed, exonephric parietal micronephridia from ix posteriorly on each side, each nephridium with a longitudinally placed bladder (?); from ix anteriorly nephridia in clusters on anterior faces of septa. Holandric, seminal vesicles in xi and xii. Prostates racemose.

The gizzard in viii and the paired supra-intestinal excretory ducts are similar to conditions in *Pheretima* but the open enteronephric meganephridia are like those of *Lampito*. The supraintestinal excretory ducts are more widely separated than in *Pheretima*. Intestinal gizzards are known elsewhere only in the Lumbricidae.

Genus DIPLOCARDIA Garman, 1888

Diplocardia is of particular interest because of marked, intrageneric variation in characteristics usually uniform in Megascolecid genera or even through groups of genera of considerable size. The male pores, almost always on xviii in the former subfamily Megascolecinae—as well as in considerable sections of the Acanthodrilinae, Octochaetinae and Ocnerodrilidae, may here be on any segment from xviii to xxi. The primitive condition, location of male pores on xviii, is found only in one species, a Mexican form. Species with male pores on xix are recorded from southern Florida north into Ohio, Indiana, Illinois and Missouri. One species with male pores on xx is known with certainty only from Nebraska with doubtful records (possibly of other species) from Illinois and Ohio. Species with male pores on xxi have been found in Texas and Lower California.

The intestinal origin, so often in xv in the Megascolecidae, may in *Diplocardia* be in any segment from xiv or xv to xix or xx, and apparently without intraspecific variation. In xiv (? but perhaps doubtfully and possibly rather in xx, *vide* Eisen, 1900), in *koebelei* (Mexico); in xv, in *keyesi* (Lower California); in xvi, in *verrucosa* (Nebraska); in xvii, in *communis* (Illinois), *caroliniana* (North Carolina), *floridana*, *mississippiensis*, singularis (Illinois), *udei* (North Carolina), and two new species (from Texas and Tennessee); in xviii, in *eiseni* (Florida), *longa* (Georgia), *michaelseni* (North Carolina), *riparia* (Illinois), and two new species (from Florida and Tennessee); in xix, in *texensis;* possibly in xx, *koebelei* (Mexico). Assuming that an intestinal origin in xv is primitive and that the greatest departure therefrom is the most highly specialized, the primitive species is Mexican while the most specialized are in Texas and possibly Lower California.

The primitive spermathecal battery presumably comprises four spermathecae and quadrithecal species have been found from Mexico to Nebraska while sexthecal species are now known only from an area including Georgia, North Carolina, Tennessee and Illinois. Species with last hearts in xii are present from Mexico to Nebraska but those with hearts in xiii have been found only in the area from Florida and Texas north through Georgia and Mississippi into Illinois.

Smith (1924) commented on the absence of calciferous glands in species from the north central states and the presence of such glands or high lamellae in forms from the southern states, North Carolina to Florida and Mississippi. New species from a more southern portion of Florida and from Texas, however, have as rudimentary lamellae as any of the more northern forms.

Designation of known species as definitely primitive or highly specialized is impossible, the one with primitive intestinal origin has the greatest degree of specialization in posterior dislocation of male pores, while the species that is primitive with regard to location of male pores may have the most posterior intestinal origin. Species with greatest development of calciferous glands (internal) have male pores on xix only slightly behind the primitive location.

Diplocardia alba sp. nov.

Material examined.—Roadside ditch, Yellow Fern Creek, Fort Myers, Lee County, Florida, January 21, 1941, 12 partially clitellate or clitellate specimens. Prof. W. M. Barrows. Roadside ditch, Fort Myers, Florida, February 19, 1941, 6 small juveniles and 31 partially clitellate or clitellate specimens. Prof. W. M. Barrows.

External characteristics.—Length to 75 mm. Diameter 2 mm. Unpigmented. Prostomium apparently epilobous but with no transverse furrow at posterior edge of tongue. Nephropores are not certainly recognizable but appear to be on *d*. Setae begin on ii on which all four couples are present; on xxiii, $ab < cd < bc < aa$, *dd ca.* = ½C; ventral setae of xviii–xx unrecognizable (16), on viii–ix usually deeply retracted into the parietes and with the tips just visible in the epidermis or invisible, in which case the openings into the setal follicles are clearly visible. The first certainly functional dorsal pore is located on 10/11 (4), 11/12 (11) or 12/13 (1) but one or two rather pore-like markings anteriorly may represent functional pores. The clitellum is light yellow, slightly protuberant when fully developed, annular, extending from 12/13 to 17/18 (16), the clitellar coloration lacking in *aa* on xiii and xvii; sites of intersegmental furrows slightly indicated (more so ventrally), dorsal pores lacking, setae present.

Quadrithecal, spermathecal pores minute, about the same size as apertures of setal follicles, on viii and ix, in *ab*, usually slightly nearer to *b* than *a*, the anteroposterior location variable; slightly behind 7/8 and 8/9 (21); slightly behind 7/8, midway between 8/9 and setal arc of ix (8); slightly behind 7/8, just in front of setal arc of ix (5); midway between 7/8 and setal arc of viii, on or just in front of setal arc of ix (9). Female pores are minute, anteromedian to *a* and slightly nearer to the *a* setae than to each other (16), on an indistinctly demarcated, transversely placed area of epidermal whitening. On one specimen there is a single median female pore.

A male genital shield is not definitely marked off but an area between the setal arcs of xiii and xx may be very slightly protuberant. Seminal grooves are nearly straight, fairly deep—the median margins especially tumescent, in *ab*, between setal arcs of xviii and xx. Prostatic pores (not always recognizable) are at the termini of the seminal grooves. Male pores are minute, each pore on a tiny, knob-like protuberance from the lateral wall of the seminal groove, the knob about on the setal arc of xix. There are no genital markings but a tiny, circular area around each aperture of the ventral setal follicles of viii and ix is greyish translucent and within a small, circular area of slight tumescence.

Internal anatomy.—All septa are present from 5/6; 7/8–9/10 most opaque but no septa thickly muscular.

Gizzards are in v and vi (16). The gut is slightly widened at 12/13. In xiv–xvi on the inner wall of the gut there are very low, longitudinally placed lamellae which are less obvious in xiii though the outer wall in that segment is as vascularized as in xiv–xvi. The intestine begins in xviii (10), the oesophageal valve anteriorly in the same segment. The typhlosole is represented by a very low, whitish ridge which begins in xviii and is unrecognizable behind lxvi or lxxvi (worm with 131 segments).

The dorsal blood vessel is doubled from xvii through vii (13) or vi (1), the doubled portions widely separated, the trunk simplex in the region of the septa. The trunk may be slightly doubled in xviii and perforate in xix (2) but apparently is never doubled anterior to 5/6. A supra-oesophageal trunk is unrecognizable, the extra-oesophageals recognizable only in v–vi beneath the gizzards and even there empty. Apparently no subneural (10). Vascular loops in x–xiii are larger than anteriorly and with two branches dorsally from each loop, one to the dorsal trunk and the other to the gut but both branches are filamentous and without blood. The last pair of hearts is in xiii (16).

Nephridia begin in ii. Preseptal funnels have been found only in the posterior segments and are close to the ventral parietes in *ab*.

Testes, free in x and xi, are bifid or trifid and flattened. Male funnels are large and with marked iridescence. Coelomic cavities of x and xi are filled with coagulum. Seminal vesicles are in ix and xii (16), the posterior larger. Prostates are in xviii or xviii–xix and xix–xx and are fairly short, not much longer than the ducts, flattened. Prostatic ducts are over two mm. in length, with marked muscular sheen, C-shaped with a short and narrowed ental portion in one or two U-shaped loops. The male deferent ducts of a side come into contact posteriorly in xii and from thence on may be looped, the loops protuberant from the parietes, passing laterally but close to the prostatic ducts of xviii and into the parietes in xix midsegmentally, the ducts united just within or just prior to entrance into the parietes.

The spermathecal duct which is clearly marked off from the rather heart-shaped ampulla is narrowed within the parietes in a rather conical fashion and widened entally from just below the region of the diverticular junction. The lumen is large entally and elliptical in cross section but ectally is narrow. The pendent diverticulum which opens through a slight conical protuberance apparently on the lateral face of the duct (spermathecae usually slightly twisted) near the ampulla by a pore on a small tubercle, vertical ridge or prominence, comprises an ellipsoidal seminal chamber and a very short and slender stalk almost at right angles to the chamber. Occasionally the spermatozoa in the seminal chamber are in one large ventral and one, two or three smaller masses dorsally, slight furrows on the surface of the stalked end of the diverticulum partially marking off small lobes.

Copulatory setae (ventral couples of viii–ix) are curved slightly in a sort of arc, the tip somewhat hastate but with a rather shallow, scoop-shaped depression on the side of arc concavity, ornamentation of 12 to 16 irregularly and widely interrupted circles of closely crowded, fine spines. At the margins of the shafts light transparent spots are visible just ectal to the circles of spines and the margin is incised. Setal follicles are present within the parietes on the median faces of the prostatic ducts but scarcely reach into the coelomic cavities. Attempts to remove the setae failed.

Abnormality.—One specimen lacks the right anterior prostate and duct.

Remarks.—The intestine of one specimen, aside from a brown flecked slime and a few scattered bits of black organic matter, is filled with quartz pebbles.

Of those species of *Diplocardia* with male pores on xix, only *eiseni* (Michaelsen) 1894 and *mississippiensis* Smith 1924 have hearts in xiii and a doubled dorsal blood vessel. *D. alba* is distinguished from *eiseni* by the presetal location of the spermathecal pores and absence of high, lamellar folds in the calciferous section of the gut, and from *mississippiensis* by the absence of calciferous glands, the rudimentary typhlosole and the simple spermathecal diverticulum.

D. eiseni and *D. floridana* Smith 1924 are the only species hitherto reported from Florida. From *floridana*, *alba* is distinguished by the rudimentary typhlosole, the presence of hearts in xiii, the simplex condition of the dorsal trunk in xx–xxv, absence of calciferous glands and the simpler spermathecal diverticulum.

Diagnosis.—Male pores on xix on setal arc, on very small knobs on lateral walls of straight seminal grooves extending in *ab* between setal arcs of xviii and xx. Prostatic pores at termini of seminal grooves and on setal arcs of xviii and xx. Quadrithecal, spermathecal pores on presetal portions of viii and ix in *ab*. Female pores anteromedian to *a*. Setae: $ab<cd<bc<aa$, *dd ca.* = ½ C, ventral setae of viii–ix slightly arced, tip rather hastate but slightly hollowed on concave side of arc, ornamentation of irregularly interrupted circles of very fine spines; (penial setae?). Clitellum annular, 12/13–17/18. First dorsal pore on 10/11–11/12. Unpigmented. Length to 75 mm. Diameter 2 mm.

Gizzards in v–vi; no calciferous glands, longitudinal lamellae in xiv–xvi low; intestine begins in xviii, typhlosole rudimentary. Dorsal blood vessel double in vii–xvii; last hearts in xiii. Spermathecal duct as long as ampulla, a pendent diverticulum with ellipsoidal seminal chamber opening by a very short and slender stalk through a conical protuberance on lateral face of duct into a widened ental portion with large lumen.

Distribution.—Known only from the type locality, Fort Myers, Lee County, Florida.

Diplocardia fusca sp. nov.

Material examined.—Agricultural soil, Fort Worth, Texas, March, 1941, 1 aclitellate specimen. Prof. R. F. Chandler, Jr.

External characteristics.—Length (strongly contracted) 292 mm., the last eight segments uniformly small and possibly regenerate. Diameter 8 mm. There is at least one metameric abnormality in the posterior half of the body. The dorsum of the anteriormost forty mm. is a fairly dark brown, but posteriorly the color rapidly disappears until the dorsum appears to be white though scattered brown flecks are still recognizable for some distance under the binocular, the pigment again recognizable and fairly dense on the dorsum of the last twenty mm. The prostomium is slightly proepilobous. From ii posteriorly there are two deep secondary furrows on each segment. From vi posteriorly a tertiary furrow is present on each of the first and third secondary annuli. Passing posteriorly these tertiary furrows become as deep as the secondary furrows. Nephropores are slightly dorsal to *d*, on the anterior margins of the segments from iii posteriorly. A pair of pit-like depressions on ii probably are nephropores as nephridia are present in ii. Setae are unrecognizable wholly or in part on the anterior segments. On xxiii the formula is approximately as follows: $ab : cd : aa : bc :: 1 : 1 : 4 : 7$, *dd ca.* = ½ C. The first dorsal pore appears to be on 12/13 but there is a pore-like marking on 11/12.

Spermathecal pores are quite small, transversely placed slits on vii and viii *ca.* on *a*, very slightly behind 6/7 and 7/8. Female and male pores are unrecognizable. Prostate pores are transversely slit-like, at the termini of the seminal grooves on the setal arcs of xviii and xx and somewhat median to *b*.

Seminal grooves are slightly concave laterally, reaching to the setal arcs of xviii and xx about at mid *ab* and mesially on xix to *a*. A genital shield is not marked off, a median region between the *a* lines of xix slightly depressed. Setae *a* and *b* of xviii and xx are closely paired and just median to the prostatic pores, the *a* setae slightly displaced laterally, the *b* setae even more displaced mesially. Ventral setae of xviii if present are unrecognizable. Transversely placed, anteroposteriorly short tumescences reaching laterally on each side nearly to *a* on 17/18, 18/19, 19/20 and 20/21, with smooth, glistening, convex surfaces, may be genital markings.

Internal anatomy.—Septum 4/5 is present but delicate, 5/6 strengthened but transparent, 6/7–10/11 thickly muscular, 11/12 muscular and opaque but not as thick as 10/11, 12/13 strengthened but slightly translucent, 13/14 and several succeeding septa strengthened but increasingly transparent.

Gizzards are in v and vi. In vii–ix the inner wall of the oesophagus is marked off into low, longitudinal, white ridges. Midsegmentally in each of segments vii–ix and transversely placed on the dorsal surface of the gut is a small but quite obvious, lobulated ridge of a slightly iridescent (glandular?) material. There are no lamellae or calciferous glands but in xi–xiii the inner wall of the oesophagus is provided with numerous, closely crowded, dark red, papillose projections, often pear-shaped or shortly ridge-like. The projections are less marked in x and decrease in size gradually in xiv to mid xv where they end. On the floor of the gut at the median line in xi–xvi there is a fairly high, dark red ridge somewhat like a typhlosole. The inner wall of the gut in the posterior half of xv and in xvi is smooth and with a rather velvety appearance. The oesophageal valve is in the anterior portion of xvii, the intestine beginning abruptly in the posterior half of xvii. The typhlosole begins abruptly in xxii and is of the simple, lamellar type, about two mm. high, the lumen slit-like in cross section and filled with blood. The typhlosole gradually decreases in height posteriorly and is unrecognizable behind cxxiv at a point 138 mm. from the anterior end. Presumably as a result of the strong contraction of the worm the typhlosole is folded in a regularly zigzagged manner. On the floor of the gut in xlviii–lxxxvi, just lateral to the median line on each side, there is a well marked, dark red, longitudinal ridge.

The dorsal blood vessel is doubled in v–xv and anterior to 4/5 remains doubled until it disappears from sight in the pharyngeal bulb. In xvi–xviii the doubled portion is considerably shortened. From xix the dorsal trunk is perforated midsegmentally, the perforations at first large enough to permit passage of a pin but filled with chloragogen. Posteriorly the perforations become smaller and eventually disappear as the trunk loses its broad, flattened appearance and becomes more nearly circular in section. The supra-oesophageal trunk disappears into the gut slightly behind 13/14 and is continued forwards to 9/10. Anterior to that septum the supra-oesophageal appears to be continued as a somewhat irregular, small vessel to 6/7 but is paralleled on one side from 9/10 to 6/7 by a slightly smaller vessel. The extra-oesophageals pass onto the ventral surface of the gut in xi and unite mesially in xiii, passing through 4/5 close to the ventral parietes and then turning upwards to unite just underneath the dorsal trunk so that the vertical portions in front of 4/5 at first look like commissures from the dorsal vessel. Several large vessels from the dorsal face of the pharyngeal bulb pass into the extra-oesophageals and also a large vessel on each side from the ventral parietes. The extra-oesophageals are in communication with each other through short, transverse connectives in vii and ix. The ventral trunk bifurcates just in front of the suboesophageal ganglia, the two branches passing laterodorsally. There is no subneural trunk. Hearts of x–xiii are latero-oesophageal, opening into both dorsal and supra-oesophageal trunks. Smaller loops, in v–ix, open only into the dorsal trunk. All loops and hearts pass into the ventral blood vessel.

Nephridia begin in ii and gradually increase in size posteriorly but in xxiii reach only just beyond *d*. The necks (preseptal) which are long enough to reach half way or more towards the anterior septa are close to the ventral parietes at or just lateral to *b*. The neck terminates entally in a small, dark annulus of the same diameter as the neck so there is practically nothing of a "funnel" shape.

Testes are fairly large, bushy masses free in x and xi. Male funnels are rosette-shaped, those in xi with a very slight iridescence, possibly spermatozoal. Seminal vesicles, in ix and xii, are medium-sized and acinous. The prostates are not confined to single segments. The ducts are three to four mm. long, slender, nearly straight, with slight muscular sheen.

The spermathecal duct is of about the same length as the (probably strongly contracted) ampulla and only slightly narrower. Ectally the lumen is transversely slit-like in cross section but entally is widened and rather star-shaped in cross section due to the presence of several longitudinal ridges that nearly meet in the center. The lateromesially flattened diverticulum is on the anterior face of the duct and connected to the septum next in front by a mesentery. Only the ental half is attached to the duct. In the anterior portion of the diverticulum are several small seminal chambers, each apparently opening into a vertical passage (circular in cross section) located in the portion next to the duct and which opens through a single pore into the duct near the ampulla.

Iridescent material, probably spermatozoal, is present in some of the seminal chambers though this was discovered only on dissection.

Remarks.—Lips of spermathecal and prostatic pores are in apposition, the pores recognizable only after slight traction in the neighboring region has separated the lips. Before this was observed very definite grey, translucent spots on 6/7 and 7/8 (as well as on 8/9) just in front of the real spermathecal apertures were suspected of being sites of the pores. Inability to remove cuticle from a recently preserved specimen may explain failure to recognize male and female pores.

The clearly visible nephropores enabled confirmation of a prior segmental enumeration, a matter otherwise of some difficulty because of the depth of secondary and tertiary furrows and also because of the absence or invisibility of setae anteriorly.

The vasa deferentia were not traced and no effort was made to remove the penisetal follicles of xviii and xx, or what appeared to be follicles of the ventral setae of xviii, or the ventral setae of vii–ix.

The spermatozoal iridescence in the seminal chambers of the spermathecae would appear to indicate a postsexual condition, but no evidence of clitellar regression was recognized.

D. fusca is perhaps as close to *alba* as to any species now known and is distinguished therefrom by the larger size, the location of the spermathecal pores on vii and viii, the more anterior intestinal origin, the larger typhlosole and characteristics of the spermathecal diverticulum.

One other species, *D. texensis* Smith 1924 has been recorded from Texas (Chillicothe) but is clearly distinguished from *fusca* by location of the prostates and male pores on xx-xxii, absence of hearts of xiii, the simplex condition of the dorsal blood vessel, as well as other important characteristics.

Although a satisfactory diagnosis cannot be given until clitellate specimens have been examined *D. fusca* is clearly distinguished from all other species by its large size and from other quadrithecal species by the location of the spermathecal pores on vii–viii.

Diplocardia gracilis sp. nov.

Material examined.—(Lebanon?), Tennessee, October 6, 1914, 1 clitellate specimen. Prof. H. A. Hill per U. S. Nat. Mus.

External characteristics.—Length 68 mm. Diameter two mm. Pigmentation unrecognizable (alcoholic preservation). The prostomium is proepilobous, the indentation of i slight. Secondary furrows are recognizable only posterior to the clitellum, one presetal and one postsetal on each segment. Nephropores, at least from v posteriorly, are on or slightly dorsal to *d*. Setae begin on ii on which all four couples are present; on xxiv, *ab ca.* = *cd*, *bc* < *aa*, *dd ca.* = ½ C. The first dorsal pore is on 9/10. Clitellar coloration, a faint yellowish, is recognizable with the binocular on xiv–xvii, the epidermis of those segments clearly though but slightly thickened at the mid-dorsal incision as well as midventrally in *aa*.

Quadrithecal, spermathecal pores minute, postsetal on viii and ix, slightly nearer the setal arcs than to the intersegmental furrows, slightly median to *b* except the left posterior pore which is about at mid *ab*. The margin of each aperture is opaque, the pore centrally located in a tiny, slightly depressed, circular area of greyish translucence. Female pores are very slightly median to *a* and about midway between 13/14 and the setal arc.

Seminal grooves are nearly straight, just median to *b*, reaching nearly to the setal arcs of xviii and xx. Male pores are in the seminal grooves slightly behind 18/19 on tiny rounded tumescences. Prostatic pores are just lateral to the termini of the seminal grooves and about on *b*. Just median to the prostatic pores and about at the ends of the seminal grooves are the very closely paired apertures of the penisetal follicles of xviii and xx.

Genital markings are transversely placed areas of brownish translucence in *aa* at the posterior margins of xxi–xxvi (furrows 21/22–22/23 invisible ventrally). On each of these areas there are visible, but only with right direction of light, three, tiny, circular opaque spots.

Internal anatomy.—None of the septa are especially muscular.

Gizzards are in v and vi. The gut is slender in ix–xvii, the inner wall in x–xv provided with low, papillose protuberances in several longitudinal rows, calciferous glands and lamellae lacking. The intestine begins abruptly in mid xviii, the oesophageal valve anteriorly in xviii. The typhlosole which begins in xx is fairly high and thickest ventrally, rather oval in cross section, the lumen—filled with blood—also oval in section.

The dorsal blood vessel is single. Extra-oesophageal trunks are present. No subneural trunk. The last hearts are in xii.

Holandric, the male funnels small and with thick, rounded rims. Seminal vesciles are acinous and in ix and xii. Prostates are restricted to xviii and xx, the ducts *ca.* one mm. long, shorter than the glands, nearly straight, slender, with slight sheen. Male deferent ducts of a side pass in xviii close to the prostatic ducts laterally and then into the parietes just behind 18/19, uniting within the body wall. Two penisetal follicles project conspicuously into the coelomic cavities just median to each prostatic duct but are less than half as long as the prostatic ducts. The main portion of the shaft of a penial seta is nearly straight but an ectal portion is slightly curved the arc of curvature variable, several setae bent at region of curvature. The tips of some are bifid. One seta, apparently the least worn, has a deep incision marking off slightly ental to the tip a large, triangular tooth. The bifid appearance of the other setal tips is then presumably due to erosion of the real tip. Ornamentation sparse, of several circles of fine spines, not always recognizable (worn?).

The spermathecal duct is about as long as the ampulla from which it is clearly marked off, narrowed in the parietes and widened from below the diverticular junction entally. The single diverticulum is lateromesially flattened, the pointed ventral end reaching to the parietes, the dorsal half adherent to the anterior face of the duct, opening into the duct entally but quite definitely below the ampulla.

Ventral setae of viii and ix but not of vii and x are enlarged, without noduli, slightly curved, with simple tips, ornamentation of three or four longitudinal rows of four or five elongated but slender spines. Near each spine there is a longitudinal groove or slit (possibly an artefact).

The body wall is uninterrupted over sites of the genital markings but in section the epidermis (or an outer portion) of the white circles appears to be transparent thus permitting recognition of a small, opaque body, possibly a gland or entral modification of the epidermis.

Remarks.—Spermatozoal iridescence on the male funnels indicates sexual maturity but there is no iridescence in the spermathecal diverticula and the clitellum certainly does not appear to be fully developed. The bending of ectal portions of the penial setae may have been produced in removal of the setae but erosion of tips and ornamentation may be evidence for believing that the worm is in a postsexual stage of clitellar regression.

D. gracilis with four spermathecae, single dorsal blood vessel and last hearts in xii is close to *D. udei* Eisen 1899 from which it is distinguished by the following characteristics: (1) proepilobous prostomium, (2) location of first dorsal pore on 9/10, (3) absence of genital markings in *bc*, (4) presence of genital markings in *aa*, (5) postsetal location of spermathecal pores, (6) presence of a definite, external spermathecal diverticulum, (7) absence of copulatory setae in x, (8) intestinal origin in xviii, and possibly also by differences in the setal formula, shape and ornamentation of copulatory and penial setae.

Diplocardia ornata sp. nov.

Material examined.—(Lebanon?), Tennessee, October 6, 1914, 7 aclitellate and 49 clitellate specimens. Prof. H. A. Hill per U. S. Nat. Mus.

External characteristics.—Length 70–110 mm. Diameter 2–3½ mm. Pigmentation unrecognizable (alcoholic preservation). Prostomium tanylobous (53). On v or vi to xii each segment may have two secondary furrows, one presetal and one postsetal. Posterior to the clitellum secondary furrows are usually unrecognizable. Nephropores from iii posteriorly are on or slightly dorsal to *d*, on ii in line with furrows forming the lateral margins of the tongue of the prostomium or slightly ventral thereto. Setae begin on ii on which all four couples are present; on xxiv, $ab < cd$, $bc < aa$, dd *ca.* $= \frac{1}{2}$ C. The first dorsal pore is on 10/11 (25) but on sixteen of those specimens there is a more or less pore-like marking on 9/10 which may indicate on a few of the specimens presence of a functional pore. The clitellum is reddish brown and, with greatest development, extends from 12/13 to 18/19 but may be lacking or almost unrecognizable on xiii and xviii and even with full development on those segments the clitellar epidermis is much thinner than on xiv–xvii, lacking in *aa* which is always white. Intersegmental furrows more or less definitely indicated, dorsal pores usually lacking, setae present.

Sexthecal, spermathecal pores tiny (slightly larger than the female pores), transversely or diagonally placed slits on the anterior margins of vii–ix just behind the intersegmental furrows, on or just lateral to *a*, each pore on a slightly tumescent, greyish translucent area often markedly protuberant like a small tubercle and reaching to the intersegmental furrow in front. On one worm the right pore of viii is on *b*. Female pores are anteromedian to *a*, closer to each other than to *a* or nearer to *a*, nearer the setal arc than 13/14, on a transversely placed area of marked epidermal thickening that may reach laterally to *a* or *b*, the outline elliptical.

Seminal grooves are in *ab*, usually perhaps nearer to *b*, nearly straight (apparently often distorted by some local contraction) and reaching almost to the setal arcs of xviii and xx. Male pores are in the seminal grooves behind 18/19 and may or may not be on tiny, rounded tubercles which vary in position from just behind 18/19 to level of a presetal secondary furrow. A genital field is not marked off but lateral or median or both margins of the seminal grooves may be more or less markedly tumescent or each groove may be within a longitudinally placed area of tumescence as in certain species of *Dichogaster* or some of the Ocnerodrilids, or tumescence may be recognizable only in nearly circular areas around the termini of the seminal grooves. Prostatic pores are just lateral to the termini of the grooves, about on *b*, the very closely paired apertures of the peni-setal follicles at the termini of the grooves.

Genital markings of 20 specimens are located as follows: 15/16 (4), 16/17 (20), 17/18 (20), 20/21 (4), 21/22 (19), 22/23 (19), 23/24 (18), 24/25 (5). These markings are recognizable and their characteristics determinable only with some difficulty. On the clitellar region with recognizable individual peripheral and central portions (both opaque), paired, closely in *aa* on 15/16, more widely separated on 16/17 (with centers on or close to *a*), still more so on 17/18 (with centers on or near mid *ab*). Posteriorly markings may have much the same appearance as anteriorly and be also widely separated, but more usually all that may be recognized are transversely placed areas of brownish translucence, at first in *bb* but posteriorly contracting into *aa*. On each of these areas, with proper illumination there are recognizable tiny, sharply demarcated, circular areas of opacity, of which there may be four, three or two, or occasionally one—asymmetrical, in transverse rows.

Internal anatomy.—Septa 5/6–6/7 are strengthened but transparent to translucent, 7/8–10/11 muscular but not especially thickened, 5/6–8/9 funnel-shaped.

Gizzards are in v–vi (10) but 6/7 comes into contact mesially with the gut at or just in front of the anterior margin of the posterior gizzard and must be peeled off carefully before the correct location is recognizable. The gut in ix–xvi usually is rather slender. On the floor of the oesophagus in x–xiv is a fairly high longitudinal ridge gorged with blood (10). On the inner walls of the gut in x–xiii there are numerous papillose protuberances (gorged with blood) with a recognizable tendency to arrangement in longitudinal rows but lamellae and calciferous glands are lacking (10). The intestine begins in xvii (10), the oesophageal valve anteriorly in xvii or at the region of attachment of 16/17. The typhlosole begins in xix or xx (10) and is a fairly high (*ca.* one mm.), simple lamella, with lumen vertically slit-like in cross section and filled with blood, gradually decreasing in height posteriorly and unrecognizable behind lxvii–lxx.

The dorsal blood vessel is single (10). A supra-oesophageal trunk is recognizable between 8/9 and 12/13. Extra-oesophageal trunks pass onto the gut in ix and unite mesially in xiii or xiv, anterior to 4/5 with one large branch close to the ventral parietes forwards to i, and smaller branches to the lateral and dorsal faces of the pharyngeal bulb. The ventral trunk bifurcates just anterior to the subpharyngeal ganglia. No subneural trunk (10). Hearts of x–xii are latero-oesophageal but the branch to the dorsal trunk is slender and white. The last pair of hearts is in xii (10). In xiv on each side there is a fairly large, longitudinally placed vessel on the parietes latero-ventrally. In xiii that vessel turns dorsally and eventually passes to the ventral face of the gut and possibly to the extra-oesophageal, a loop occasionally reaching up nearly to the dorsal trunk with something of an appearance of a heart.

Nephridia, behind the clitellum, reach laterally on the parietes about to level of *d*, funnels small, close to the ventral parietes slightly lateral to *b*. Funnels of nephridia of ii have not been found.

Holandric, male funnels rosette-shaped and with brilliant spermatozoal iridescence. Seminal vesicles are in ix and xii, acinous (10). Prostates are relatively large and extend through several segments, as many as ten to twelve. The ducts are slender, with slight sheen, *ca.* two mm. long, looped entally, slightly longer (*ca.* ½ mm.) than the penisetal follicles. In xviii the male deferent ducts of a side pass just lateral to the prostatic duct, penetrating into the parietes slightly behind 18/19, uniting just within the body wall.

Penial setae are more than one mm. long, variously curved but not S-shaped, the tip slightly flattened on opposite sides, ornamentation of rather widely separated circles of saw-teeth-like appearance. Setae are often bent, wrinkled, with tips broken off, occasionally with slight fibrillation of the ectalmost portion, the ornamentation apparently more or less eroded.

The spermathecal duct is narrowed rather abruptly near the parietes, rather conical within the body wall, sharply marked off from the wider, often rather heart-shaped ampulla. On the anterior face of the duct near the ampulla is a thick-walled, hemispheroidal protuberance which is continued ectally for a short distance within the wall of the duct and finally opening into the duct lumen. Immediately lateral to that chamber is a lateromesially flattened, vertically placed diverticulum with pointed lower end reaching to or nearly to the ventral parietes, adherent to the duct by the upper half and apparently opening into the duct lumen independently. When filled with spermatozoa slight constrictions may mark off two, three, four or five lobes.

The ventral setae of vii-ix are sigmoid but ornamented ectally by short, transversely placed rows of fine spines. These setae are slightly larger than the ventral setae of vi and x which are similarly ornamented.

The longitudinal musculature is uninterrupted over the sites of genital markings which are areas of marked epidermal thickening.

Abnormalities.—One specimen has a spiral metameric abnormality in the clitellar region; right spermathecal pore of viii lacking, clitellum one segment further anteriorly on the right side and two segments further posteriorly on the left side with abrupt demarcation on the three segments exactly at the mid-dorsal line, seminal grooves on two segments only and one segment behind on the left side, right female pore on xiii, right heart of xii lacking, a seminal vesicle in xi—right side, right posterior vesicle rudimentary, right ovary in xii, left posterior prostate lacking, right posterior prostate rudimentary.

In another worm the ampulla of the left anterior spermatheca is completely divided into three lobes, the median and lateral ellipsoidal, smooth-surfaced and distended by hard translucent material, the middle lobe slightly larger and more irregular.

Parasites.—On the cuticle of several specimens there are numerous small, whitish cysts of rather variable size and shape. Each cyst has a thick rind composed mainly of radially placed, needle-shaped crystals apparently of calcium carbonate. Occasionally cysts are closely crowded into plates a millimeter or so in diameter in which definite boundaries of cysts are indistinct or unrecognizable.

Remarks.—Genital markings are no more easily recognized on fully sexual specimens than on the type of *gracilis*.

Gizzards have been located in vi–vii in two species of *Diplocardia* but in one of these the location has been corrected by Stephenson (1933) to v–vi. In the remaining form location in vi–vii may need confirmation, especially in view of the confusion that might be caused by the adherence of funnel-shaped septa to the gizzards.

With six spermathecae, single dorsal blood vessel and last hearts in xii, *D. ornata* is close to *D. singularis* (Ude) 1893 and *D. caroliniana* Eisen 1899 from which it is distinguished as follows: From *singularis* by (1) the tanylobous prostomium, (2) location of first dorsal pore on 10/11 (or even 9/10), (3) location of nephropores on or dorsal to *d*, (4) segmental location of the spermathecal pores, (5) saddle-shape of clitellum, (6) ornamentation of the penial setae, (7) location of genital markings in *aa*, (8) location of genital markings on intersegmental furrows, (9) presence of thick-walled accessory diverticulum on the spermathecal duct, (10) shape of spermathecal diverticulum, and possibly also by differences in setal formula. From *caroliniana* by (1) the tanylobous prostomium, (2) location of first dorsal pore, (3) saddle-shape of clitellum with posterior boundary at 18/19, (4) location of prostatic pores on *b* and slightly more lateral location of the seminal grooves, (5) presence of accessory chamber or diverticulum on spermathecal duct, (6) shape of spermathecal diverticulum, (7) definitely marked off, relatively wider and shorter spermathecal ampulla, (8) circles of saw-tooth ornamentation on penial setae, and possibly also by a more anterior location of the male pores (vide Eisen, 1900, pl. xiii, fig. 137b). Original descriptions of both species (Eisen, 1899) are unavilable as also the types.

In view of the differences in method of preservation and in manner of description, the possibility of variations in connection with certain characteristics as well as of deformations that may affect recognition of characteristics of penial setae, determination of the taxonomic value of some of the apparent distinctions is at present difficult. Some of the differences listed would not be regarded as of taxonomic value in certain other Megascolecid genera. The distinctions are so numerous and so consistent on all of the material examined that it seems advisable at present to regard the Tennessee forms as specifically distinct from both *singularis* and *caroliniana*. Recharacterization of both species from properly preserved, sexual material from type localities is needed. There is also reason for suspecting that worms from Illinois and Indiana which have been identified as *singularis* differ from the types (or perhaps only from the original description) in ways that are more important than has been recognized (vide Eisen, 1900, and Heimburger, 1914).

Diagnosis.—Male pores slightly behind 18/19, in straight seminal grooves extending in a lateral portion of *ab* between setal arcs of xviii and xx, prostatic pores in *b* and just lateral to termini of seminal grooves. Sexthecal, spermathecal pores slightly behind 6/7–8/9, on or just lateral to *b*. Genital markings on 15/16–17/18, 20/21–24/25, paired or in transverse rows of 4, 3, or 2. Female pores anteromedian to *a*. Setae: *ab* < *cd*, *bc* < *aa*, *dd ca.* = ½ C, ventral setae of vii–ix slightly enlarged but ornamented as on vi and x. Clitellum saddle-shaped, 12/13–18/19. First dorsal pore on (9/10) 10/11. Nephropores on or slightly dorsal to *d* but on ii at or just below levels of lateral furrows of the prostomium. Prostomium tanylobous. Pigmentation? Length 70–110 mm. Diameter 2–3½ mm.

Gizzards in v–vi; no calciferous glands or lamellae but papillose protuberances on inner wall of gut in x–xiii arranged in more or less regular longitudinal rows; intestine begins in xvii, typhlosole begins in xix–xx, of simple lamellar type. Dorsal blood vessel single, last hearts in xii. Spermathecal diverticulum lateromesially flattened, vertical, opening into duct entally just lateral to a hemispheroidal, thickwalled protuberance. Penial setae 1 mm. long, tips pointed, slightly flattened on two opposite sides, with a few circles of saw-tooth-like ornamentation.

Distribution.—The type locality is unknown but is somewhere in Tennessee.

REFERENCES

Eisen G. 1900. Researches in American Oligochaeta with especial reference to those of the Pacific coast and adjacent islands. Proc. California Ac. Sci. (3), Zool. 2.

Gates, G. E. 1929a. The earthworm fauna of the United States. Science, 70.

1929b. Earthworms of North America. J. Washington Ac. Sci., 19.

1937a. Notes on some species of *Drawida* and *Pheritima* with descriptions of three new species of *Pheretima*. Bull. Mus. Comp. Zool., Harvard, 80, (7).

1937b. The genus *Pheretima* in North America. Bull. Mus. Comp. Zool., Harvard, 80, (8).

1938. *Pheretima diffringens* (Baird) and other Asiatic *Pheretima*. Lingnan Sci. J., Canton, 17.

1942. Check list and bibliography of North American Earthworms. Am. Mid. Nat., 27, (1).

Hague, F. S. 1923. Studies on *Sparganophilus eiseni* Smith. Trans. Am. Mic. Soc., 42.

Michaelsen, W. 1900. Oligochaeta. In Schulze', Das Tierreich, 10. Berlin.

1909. The Oligochaeta of India, Nepal, Ceylon, Burma and the Andaman Islands. Mem. Indian Mus., Calcutta, 1.

Smith, F. E. 1924. The calciferous glands of *Lumbricidae* and *Diplocardia*. Illinois Biol. Mon., 9.

Stephenson, J. 1923. Oligochaeta. The Fauna of British India, Ceylon and Burma. London.

1930. The Oligochaeta. Oxford.

1933. Oligochaeta from Australia, North Carolina and other parts of the world. Proc. Zool Soc., London, 1932.

THE MECHANISM OF HEREDITY IN RELATION TO THE THEORY OF NATURAL SELECTION

W. L. McATEE
Fish and Wildlife Service, Chicago, Illinois

Darwin meant to deal with "hereditary modification" (?1912, p. 3) but he went on to include individual differences ("for they are often inherited," ibid., p. 38), which according to present information, are mostly noninheritable. Since these individual differences ("of the highest importance for us," ibid., p. 38) were postulated as the material upon which natural selection acts to produce organic modification, their prevailing noninheritance at once deals the theory a deadly blow.

As a practical consideration, vital to his theory, Darwin assumed that any variation may be inherited. In the field of individual variations, now called fluctuating variations, what is inherited is not particular variations but the tendency to vary more or less from the average racial standard. Fluctuating variations, the range of which remains about the same from generation to generation, reflect not exactness but rather the inexactness of heredity. Darwin evidently considered that all characters, all variations, of any organism are represented in its germplasm so that they may be inherited but this is now known not to be the case.

On this point D. H. Scott says, "The small variations which are so common, and on which the Darwinian tended to rely, as the material for natural selection to work on, have turned out for the most part to be mere fluctuations, oscillating about a mean, and therefore incapable of giving rise to any permanent new forms. Such fluctuating variations appear to depend on some action of the environment on the individual, and not to indicate differences in the germ-cells." (1924, pp. 10–11.)

Charles O. Whitman makes a far more sweeping statement contradicting the Darwinian view of heredity, saying: "There is really no transmission of characters anywhere in the organic world. . . . Parent and offspring are each independent developments, alike or different according as the germs from which they develop are alike or different, and according as the conditions of life are alike or different." (1919, p. 175).

THE CHARACTERS OF THE SOMA DO NOT AFFECT, AND MAY NOT REFLECT, THE CONSTITUTION OF THE GERM PLASM

When Darwin attempted to link the utility of a character with its inheritance, he was further misled. Among other ventures of this nature, he launched the following: "If variations useful to any organic being ever do occur, assuredly individuals thus characterized . . . from the strong principle of inheritance . . . will tend to produce offspring similarly characterized." (?1912, p. 115.) "variations, however slight . . . if they tend to be in any degree profitable . . . will generally be inherited by the offspring." (ibid., p. 55.)

Omitting comment on the question as to whether "variations, however slight" can be profitable, it should be pointed out that the "utility" of a character has no bearing on its hereditability. Inheritance depends upon the germ plasm while utility is an experience of the soma; there may be no connection. From this distinction ensue various considerations damaging to natural selection theory.

Without taking an extreme view as to the distinctness of somatic and germ cells (unwarranted, anyway, in the light of animal regeneration and vegetative propagation), it may be safely said, nevertheless, that in most organisms the germ plasm is a continuous stream from which the representatives of each generation derive, but upon which they do not have any effect, so far as known.

Walter notes that, "Darwin felt this difficulty and presented with apologies his provisional hypothesis of pangenesis . . . Pangenesis assumes that every bodily part sends contributions to the germ-cells in the form of 'gemmules.' Such gemmules . . . then reconstruct in the germ-cells the characters of the entire body, including acquired modifications as well as all others, and thus there is no theoretical reason why acquired characters cannot be transmitted. Unfortunately there is no tangible basis in fact for this delightfully simple explanation to rest upon. . . . Nothing we have subsequently learned of minute cell structure favors this hypothesis, while many facts go quite against it." (1930, p. 73.)

The great unanimity with which biologists have rejected the hypothesis of transmission of acquired characters (and none have been more emphatic than selectionists in this respect) is further evidence that knowledge of a mechanism for modification of the germ plasm by somatic influence is lacking.

The phenomenon of a *Begonia* leaf regenerating an entire plant, including flowers and seeds, has been urged against the theory of continuity of the germ plasm, but as bearing upon the present thesis this argument is harmless—on the contrary, indeed, it is beneficial. Vegetative propagation is the usual way of preserving uniformity in horticultural productions. Let seeds be matured and grown, however, and there occurs a flood of variation which demonstrates clearly that keeping the somatic characters to a certain standard for an indefinite period has not affected the germ cells in such a way as to make them reproduce those characters.

Maimed animals, shattered trees, leaving whole, not crippled, descendants, and moribund creatures making reproduction their last effort, prove that individuals, themselves defective, can produce normal offspring. These happenings indicate that it may make no difference whether or not there is "selection." The individual is merely the custodian and (except in a nutritive sense) not the maker of the germ plasm. It is the composition of the germ plasm that largely determines the character of the next generation. As the somatic traits of the parents (temporary harborers of the germ plasm) are not necessarily reproduced, a "selection" based on merit ("fitness") may have no influence on specific characteristics of descendants.

Morgan bluntly says "the character of the parents does not affect the properties of the germ-cells." (1932, p. 188.) Pearl may be quoted as follows: The "facts in general show that the somatic and the germinal conditions or states with reference to a particular character may be quite different in the same individual. It results, then, that the somatic condition of such a character in the progeny has no direct or necessary relation to the somatic condition of the same character in the parent. Nothing is brought out more clearly by all recent experimental studies of inheritance than that the somatic condition of a character in a particular organism is a very unreliable criterion of the probable condition of that character in the progeny of that organism. (1915, pp. 65–66.)

"Let us now turn to the consideration of our second rule, which must be fully enforced if natural selection is to be an important factor in the causation of evolutionary change. This, it will be recalled, was that the survivors must produce offspring which bear characters like those which had led to the survival. Or, to put the matter crudely, the survivors must transmit their characters to their offspring. In pre-Mendelian days this phase of the subject was always neatly and summarily disposed of by stating, as one of the *facts* on which the theory of natural selection rested, that 'variations are inherited' or 'like produces like.' Times have changed. We are a great deal less certain about that particular brand of inheritance which the theory of natural selection demands than we were before any one had taken the trouble to make experiments on heredity. The essential difficulty lies here. The differences upon which natural selection directly operates are somatic differences, by hypothesis and in fact. Every worker in genetics has learned since the truly epoch-making researches of Johannsen to be extremely cautious in assuming *a priori* that any particular somatic difference is so inherited." (Pearl, 1917, pp. 71–72.)

"Expressed in Johnansen's words, the basis of the modern conception of heredity is: 'Personal qualities are the reactions of the gametes joining to form a zygote; but the nature of the gametes is not determined by the personal qualities of the parents or ancestors in question.'" (East, 1912, p. 644.)

A bar to the success of natural selection, unknown to Darwin, is the presence of recessive genes, not apparent in an individual, but which may crop out, even with lethal effect, in descendants. It is possible, therefore, that an individual, entirely fit, might be one whose survival would insure the termination, through lethal genes in its progeny, of that particular line of descent.

Shull notes that, "An important evolutionary consequence of this lack of correspondence between the characteristics of an animal or plant and its genes is that whatever relation exists between the organism and its environment need not exist between many of its descendants and the environment, even though the environment be wholly unchanged." (1936, pp. 118–119.) The consequences of this line of argument to a hypothesis like that of natural selection, which is wholly one of environmental influence, are anything but constructive.

THE CONSTITUTION OF THE GERM PLASM DOES NOT AFFECT, AND MAY NOT REFLECT, THE CHARACTERS OF THE SOMA

"To put this thought in other words," says W. D. Lang, "the morphic expression of the difference between two forms is by no means proportional to the fundamental or genetic difference." (1921, p. iv.)

These conclusions follow from the relations of soma and germ plasm stated in preceding pages and need be repeated only for the benefit of those who consider "possibilities infinitely wider than the actual," one of which is the environmental selection of genes.

The essential independence of soma from germ is asserted by Jennings in the following passage: "Since most mutations are recessive in their effects, and since only one gene of the pair of genes present is mutated, as a rule the mutation produces no manifest effect on the individual in which it occurs. The fact of its occurrence cannot be detected in that individual. It is only when, by the processes of mating in ordinary reproduction, two of the recessive mutations get together in the same pair, in some of the descendants of this individual, that the effect of the mutation appears to view. Thus when the mutation becomes manifest, it has actually occurred, as a rule, at least two generations earlier, in one of the ancestors of this individual." (1935, p. 344.) More recently, McClung has phrased it, "By some insulating device the germinal elements within the gonad do not participate in somatic processes, but merely perpetuate themselves." (1941, p. 266.)

CYTOPLASMIC INHERITANCE

There is some evidence of cytoplasmic, as contrasted to chromosomal, transmission of characters (for a review of the literature see Sirks, 1938) but this is no comfort for selectionists as it tends to show the possibility of the inheritance of acquired characters—a principle which, so far as it is effective, renders natural selection superfluous. A recent statement, however, minimizes the importance of this type of heredity, Dobzhansky, saying "judging from the present incomplete data, cytoplasmic inheritance is so rare relative to genic inheritance that in the general course of evolution the former can hardly play more than a very subordinate role." (1937, p. 72.)

CONCLUSIONS

Hereditary modifications are now called mutations. They originate in the germ plasm and, therefore, occur first in an individual that does not, in its own body, manifest the mutation. Under natural selection theory the individual will survive or not in accordance with the fitness of its "personal" or somatic characteristics. The constitution of its germ plasm can have nothing to do with its survival. Hence the fate of a mutation at the outset is decided by chance. As mutations are of rare occurrence and as they are chiefly injurious or even lethal in effect, the probability that they can be an important factor in progressive evolution under selection theory is slight.

This state of affairs is admitted by neo-darwinians but they attempt to save the situation as best they may by pointing out that mutant genes, which by chance enter into the germinal constitution of the race, "will get distributed to many individuals, the gene complexes of no two of which are alike." (Wheeler, 1936, p. 99.) The acceptability of natural selection doctrine is not improved by this argument. It is tacit in the expression quoted and apparent from the phenomena of fertilization that each individual of a sexually reproducing organism has an unique gene complex. If it become a parent it will contribute to other gene complexes, each unique. These combinations, a different one for each successful fertilization, may be and usually are numerous. The gene complexes of offspring then are many, each with different potentialities, but they derive from parents of only two somatic complexes. Again it is evident that there can be no exact correspondence of soma and germ, hence no effectual selection of gene-complexes on the basis of somatic characters. In sexual reproduction, under the present understanding of heredity, gene complexes, whether favorable or otherwise, can not be perpetuated. Their very nature implies unending change, and as those of descendants are not like those of ancestors there is no way in which selection can get an effective grip on the process.

Weismann, the ultra-selectionist, did Darwin little service by proving the essential independence of the germ plasm from the somatoplasm. Selection, if it exists at all, must be through the medium of the soma, thus cannot act directly on the germ plasm upon which continuity of the race depends. It would seem, therefore, that there is no mechanism that can make evolution by natural selection possible.

LITERATURE CITED

Darwin, Charles. 1912? The origin of species by means of natural selection or the preservation of favored races in the struggle for life. Reprint 6th Edit., xix+501 pp.
Dobzhansky, Theodosius. 1937. Genetics and the origin of species, xvi+364 pp., 22 figs., 22 tables.
East, E. M. 1912. The Mendelian notation as a description of physiological facts. Amer. Nat., 46 (551), pp. 633–655, 1 table.
Jennings, H. S. 1935. Genetics, xi+373 pp., 70 figs.
Lang, W. D. 1921. Catalogue of the fossil Bryzoa (Polyzoa) . . . British Museum, 3(1), cx+269 pp., 8 pls., 115 figs.
McClung, C. E. 1941. Evolution of the germ-plasm. Science, 93(2412), March 21, pp. 265–268.
Morgan, Thomas Hunt. 1932. The scientific basis of evolution, 266 pp., illus.
Pearl, Raymond. 1915. Modes of research in genetics, vii+182 pp., tables.
1917. The selection problem. Amer. Nat., 51(602), Feb., pp. 65–91.
Scott, D. H. 1924. Extinct plants and problems of evolution, xiv+240 pp., 163 figs.
Shull, A. Franklin. 1936. Evolution, x+312 pp., 64 figs.
Sirks, M. J. 1938. Plasmatic inheritance. Botanical Review, 4(3), March, pp. 113–131.
Walter, H. E. 1930. Genetics, an introduction to the study of heredity, 3rd Edit., xxi+35 pp., illus.
Wheeler, W. F. 1936. Inheritance and evolution, 116 pp., 32 figs., tables.
Whitman, Charles O. 1919. Orthogenetic evolution in pigeons, I, x+194 pp., 88 pls., 36 figs.

PETROLEUM IN SOUTHEASTERN OHIO

E. WILLARD MILLER,[1]
Department of Geography, The Ohio State University

Next to Pennsylvania, Southeastern Ohio is the oldest oil producing region in the United States. However, at no time in its history has it been a large producer, and for the past forty years production has been gradually declining. This paper considers only those areas which produce Pennsylvania grade oil. All oil produced from Washington, Carroll, Columbiana, Harrison, Jefferson, Belmont, Meigs, Monroe, Hocking, Perry, Noble, and Tuscarawas counties is Pennsylvania grade, except the oil from the Corning pool in Perry county. This grade of oil is also produced in parts of Athens, Fairfield, Vinton, and Muskingum counties. Washington and Monroe have been by far the largest producers.

The pools, while numerous, are mostly small and not more than two or three include ten square miles. From the beginning of exploration in 1860 to the present time between 65,000 and 70,000 wells have been drilled, giving a developed area of more than 300,000 acres. Condit (1916) estimates the wells drilled in the Woodsfield quadrangle alone number about 2,000. There are now approximately 12,800 producing wells averaging about one-fourth barrel per day. The wells vary in depth from twelve to 3,300 feet. A number of the shallow wells, especially those in the Cow Run sand, are long lived. Wells in southeastern Ohio have nearly all been small, and the records rarely show one having an initial production as high as 500 barrels per day, though as high as 2,400 barrels has been known (Bownocker, 1921). The Pennsylvania grade oil varies from 28 to 50 degrees Baume in density. The most common color of the oil is dark green, but in places it is a bright red and elsewhere black.

GEOLOGY

The Appalachian geosyncline is the major tectonic element which accounts for the presence of oil in southeastern Ohio. The western flank of the syncline underlies this portion of Ohio. The regional dip is, therefore, to the southeast at the rate of about 35 feet to the mile (Verwiebe, 1930). At least three prominent structural features modify this large basin. Most prominent of these is the Cambridge Arch, known as the Burning Springs-Volcano anticline in West Virginia, which crosses the Ohio River into southern Washington county and can be traced into central Noble, western Guernsey, and eastern Coshocton county where it dies out. Paralleling the Cambridge Arch on the west is the deep Parkersburg-Lorain syncline. It begins in southern Washington county, trends northwest through western Morgan, western Muskingum, central Coshocton, and on into central Holmes county. Minor structural elements such as domes, noses, ravines and terraces are present in considerable abundance.

Producing Horizons.—The number of producing horizons in southeastern Ohio suffers by comparison with the large number found in Pennsylvania. Nevertheless, 24 different sands have produced either oil or gas, and of these twelve are of importance. In making correlations in eastern Ohio the principal reference bench is the Pittsburgh or No. 8 coal which lies at the base of the Monongahela formation of the Pennsylvania system. It is the most prominent coal bed of the state, and is sufficiently near the surface to act as a guide of reference to the Penn-

---

[1] The writer wishes to acknowledge the aid and information given by Dr. Wilbur Stout, State Geologist, Geological Survey of Ohio.

sylvanian and Mississippian oil horizons. In descending order the major productive sands are: (Lockett, 1942)

Sand	Depth in Feet Below Pittsburgh	Sand	Depth in Feet Below Pittsburgh
First Cow Run	300	Maxton	950
Buell Run	350	Big Lime	975
Peeker or Second Cow Run	525	Keener	1,060
Macksburg	650	Big Injun	1,100
Salt Sand Group	750	Berea	1,600

The First Cow Run sand is the principal producer in the Cow Run, Newell's Run, and Moore's Junction pools. About one-third of the wells are dry holes, because of the erratic thickness and distribution of the sand (O'Rourke, 1942). The Macksburg sand is most important as a producer in the vicinity of Macksburg, but has produced some oil and gas in Noble, Athens, Meigs, Morgan and Monroe counties. It is patchy, rather coarse, and varies from 10 to 50 feet in thickness. The Second Cow Run sand has produced only in the area where it was first named in Washington county. The Salt sand was named because of the large amount of salt water commonly found in it. Scattered gas and oil wells produce from Meigs to Columbiana county. The Maxton sand is of somewhat greater importance, but because of its position at the base of the Pottsville is extremely erratic in its distribution.

The Big Lime of southeastern Ohio has produced considerable oil and gas in Belmont, Monroe, Athens, and Washington counties. The oil lies in thin layers of quartz sand which are interbedded with shaly limestone. The Keener sand lies below this limestone. It is an important producer of gas and oil in Monroe, Washington, Morgan, Athens, Noble, Guernsey, and Belmont counties. It is formed of alternating beds of fine and coarse grained sandstones, and in many places carries considerable brine. The average thickness is from 25 to 35 feet. This sand has been most important in the Graysville, Jackson Ridge, and Moose Ridge fields. The Big Injun sand is usually separated from the Keener by a few feet of shale. Sometimes they merge, and the entire sand is called the Big Injun. Only commercial production of oil and gas has been found in Washington and Monroe counties, and has been most important in the Sistersville field. The sand is coarse textured and contains some beds of conglomeratic nature. The thickness varies from 70 to 260 feet. It contains a great deal of brine, and many good Keener wells have been ruined by drilling into Injun water.

The most important horizon for oil and gas is the Berea, an exceptionally persistent sandstone which produces in every county in southeastern Ohio. Its thickness varies from 200 feet in the northern part of the area to as little as five feet, or even disappears in the southernmost sections. As a rule it is fine grained and light colored, but contains erratic lenses of coarser sand in which the oil and gas are found. In places it is interbedded with shales, and it may be represented only by sandy shales. Because of its widespread occurrence it has become the key horizon for sub surface mapping.

Relation of Production to Structure.—In southeastern Ohio, Cottingham (1927) states, three factors appear to govern the accumulation of oil: local structure, water content and energy of movement in the sand, and the porosity of the sand. The majority of the producing fields display some relationship to structure, although the relationship is rarely ideal. It has been estimated that 65 per cent of the shallow oil sand production, including the Berea, has some structural basis (Cottingham, 1927). Most of the crests of the anticlines or domes are devoid of oil. On the whole more oil has been found in the Berea on low noses, low on flanks of folds, or in shallow synclines, than on the crestal areas. Many of the Berea pools are at the upper end of structural embayments (Condit, 1912). Porosity alone can hardly account for this situation because it occurs too frequently with the

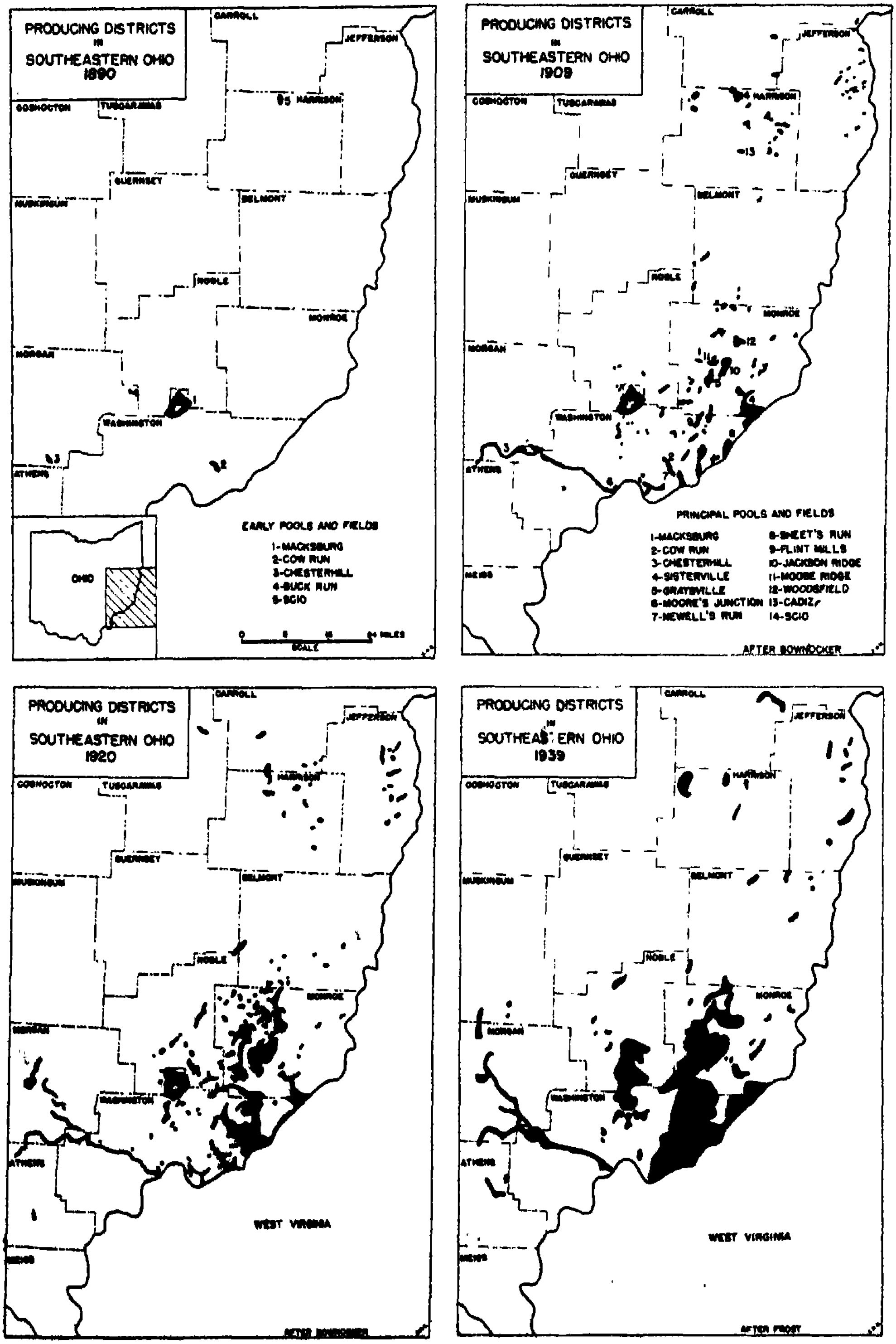


Fig. 1. The development of the Oil Region of Southeastern Ohio by periods.

same type of structure. Artesian conditions apparently prevail in the shallow sands, with the water movement being away from the hydraulic head along the Appalachian Plateau. Since the hydraulic gradient is low, and many sands are fine grained, the water movement is slow. It is possible that the disseminated oil was carried to the structural embayments and deposited because the velocity of the water movement is greatly reduced in these features (Rich, 1921). However, since so many pools are found where there are structural irregularities, it is safe to say that structure is the principal factor for the oil accumulations.

EARLY DEVELOPMENTS, 1814–1870

Oil from southeastern Ohio was known as early as 1814 when this substance was obtained as an impurity in the salt wells of Noble county. Occasionally, gas also escaped from such borings, and was looked upon with disfavor, because it was inflammable, and therefore dangerous. The first shipment of oil from this region occurred in 1843 when five barrels of "Seneca Oil" were shipped from Marietta to New York, by way of New Orleans. The oil was sold on arrival in New York to a drug house at 90 cents per gallon (Minshall, 1888). The principal use of petroleum at that time was medicinal, and from time to time small quantities were sold to drug companies. In 1852 a Pomeroy merchant made one of the largest shipments. One hundred barrels of oil were sent to St. Louis, and sold under the trade name of "Nerve and Bone" liniment (Bownocker, 1903). The first kerosene produced commercially in Ohio was distilled from Ohio shale near Buena Vista and from cannel coal from Flint Ridge, Warsaw and Canfield, about 1856–57. Twenty-five stills were in operation by 1860 and the business on a stable basis (Stout).

The finding of petroleum through drilling in Pennsylvania in 1859 prompted men in southeastern Ohio to investigate those areas where oil seeped from the earth, or gas issued from rock crevices. The first well was drilled in 1860 near a seepage on Duck Creek in Washington county. At a depth of 59 feet oil began to flow. Martin (1904) in his history of Ohio states, "In a few weeks the territory was full of prospectors and one could see derricks in every direction." Most of these shallow wells were producers, but excessive flows of water caused much trouble. In 1861 oil was discovered at Cow Run, and for a brief period this new area attracted the drillers. However, oil had been steadily declining in price, and since the only way to get it to market was to haul it by wagons over primitive roads to the Muskingum River, the profit of the individual producer was greatly reduced (Howe, 1891). Most of the shallow wells were short lived, and with the outbreak of the Civil War all efforts to develop the pools were abandoned.

The speculative flurry which swept the country at the close of the Civil War again directed attention to the oil possibilities of southeastern Ohio. Speculators from New England, New York, and Pennsylvania invaded the region for the purpose of leasing the land. Soon incorporated companies were formed with capital stock ranging from $100,000 to $1,000,000. Marietta alone had fourteen companies with a total capital stock of $8,300,000 (*Marietta Register*, March 4, 1897). At this time the greatest development occurred south of Macksburg when a 50-barrel well was drilled at a depth of only 500 feet. Drilling progressed rapidly for several weeks, but the production did not meet with expectations, and transportation was inadequate. With the passing of the period of inflation the price of oil soon dropped, and as a result of economic conditions most of the principal producers withdrew from the field. Thus, the speculative period passed with no real discovery of oil.

While these developments were going on at Macksburg, drilling was almost at a standstill at Cow Run. In the spring of 1866 a well was drilled which had an initial flow of 100 barrels per day. Here again was the great expectation, and the usual excitement. Territory that was regarded as productive sold at exhorbitant rates. Chamberlin (*Oil News*, July 29, 1899) has described the development: "Excitement ran high. At one time there was a community of thousands at the Run and the hungry prospector had a hard time to find rations. I doubt if we shall ever see in this county (Washington) again such a jam of human beings and capital on so small a space of territory. . . . The derricks were so close together that it was difficult to drive a wagon through the valley." According to Minshall (1888) the production of the field from January, 1867, to August, 1868, was about 150,000 barrels. At first the oil was hauled to Marietta by wagons, but in 1868 the first pipe line in Ohio was laid from the field to Parkersburg, West Virginia, five and one-half miles away. Most of the wells drilled were small producers and short lived so that the production in 1869 had decreased to 89,000 barrels.

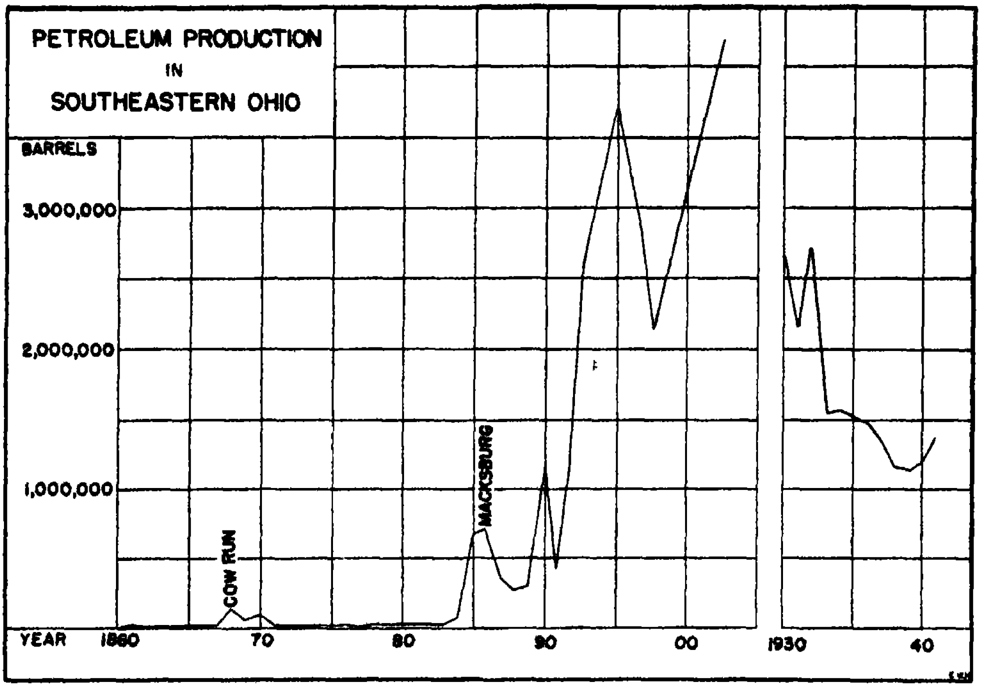


FIG. 2. Trend of petroleum production in Southeastern Ohio.

Little activity occurred until 1872 when a private producer started to survey the area around Macksburg. Minshall (1888) states, "The object of the survey seemed to be to start at Burning Springs and run a line through the producing districts of West Virginia and Ohio, taking the courses and distances of the producing wells, making a single map of the whole." During the survey a well was found that had been drilled in 1865 which was still pumping five barrels a day. After the well was cleaned out and torpedoed, production increased to 50 barrels per day. In the meantime the Cleveland and Marietta Railroad had been completed through Duck Creek Valley, making Macksburg a more desirable location for operations than it had been earlier. In 1874 one well yielded 150 barrels a day at a depth of only 150 feet. By 1877 thirty wells had been drilled in this vicinity (Lewis, 1928).

Most of the wells were either small or failures, and none went deeper than the Macksburg 500 foot sand. In 1877 a group of producers started to drill in search of the Berea sand, which was yielding oil in the White Oil district of West Virginia at a depth of about 1,400 feet. This first well in search of a deeper producing horizon reached the Berea at 1,427 feet, but it produced only brine and gas. This failure delayed the drilling of the second well until 1879, which flowed 15 barrels of oil per day, besides sufficient gas to pump the shallow wells. It was now proved that the Berea was productive in the area, but the production was too small to attract immediate attention.

MACKSBURG FIELD, 1879-1889

The development of the Macksburg field was retarded in the early 1880's by the country's financial depression which resulted in lowered oil prices, (*Marietta Times*, February 19, 1885), and by the unfavorable drilling conditions. The large body of salt water, between 900 and 1,100 feet, called for the latter amount of casing if the well was to be drilled to the Berea dry. So long as the production remained small, this added cost of casing acted as a prohibitive factor to any large scale development.

In 1883 a well was drilled on the upland which started at 100 barrels. This was the first of the large Berea producers, and at once led to extensive operations. The demonstration that oil existed beneath the hills, as well as in the valleys, greatly extended the possibilities of the field. In 1884 wells were drilled in rapid succession so that by January, 1885, more than 5,000 acres had been proved as productive territory. At that time there were 70 producing wells with a daily average of 700 barrels (*Marietta Times*, February 19, 1885). Drilling for the Berea also led to the development of the Macksburg 500 foot sand, and the Macksburg 140 foot sand. The production of the field increased rapidly as well after well was drilled. In August, 1884, it was 4,600 barrels; in December, 1884, 10,000 barrels; in March, 1885, 21,600 barrels; and in July, 1885, 79,700 barrels. From that time production decreased, the output having been 66,175 barrels in December, 1885, and 57,700 barrels in February, 1886 (Bownocker, 1903). For a yearly total the largest production occurred in 1886 when 703,945 barrels were produced.

There are no records as to the actual number of wells drilled, but the *Marietta Times* on February 5, 1885, reported, "About 100 new rigs are up in the Macksburg District for the purpose of putting down new wells," indicates that the number drilled must have been in the hundreds. The two largest wells drilled in 1885-86 are reported to have each started at 400 barrels, but the great body of Berea wells produced initially from 15 to 60 barrels per day. All contained sufficient gas to flow the oil, thus the operating costs were small.

One of the first problems with which the Macksburg producer had to contend was getting the oil to the market. The completion of a pipe line to the Cleveland and Marietta Railroad in the fall of 1883 gave temporary relief. A year later a pipe line was laid to the Muskingum River near Lowell, and the oil loaded on boats. Early in 1885 owing to cold weather the pipe lines were unable to carry the oil from the wells so that many tanks ran over, but it was considered a small loss because of the low price of oil (*Marietta Times*, February 5, 1885). In the summer of 1885 the National Transit, a subsidiary of the Standard Oil Company, laid a three-inch pipe line to Parkersburg, West Virginia. Shortly afterwards the National Transit bought the local pipe lines, and the transportation of the oil was from that time a comparatively easy problem.

As production increased at Macksburg, it became the Mecca of the oil fraternity. Hundreds of people poured into the area, largely from the Pennsylvania fields. The small country village of Macksburg grew into a city almost overnight. Hotels, saloons, drinking and gambling dens, brothels and boarding houses were built by the score. With the population increasing so rapidly a food scarcity soon faced the inhabitants. Prices increased at tremendous rates. Many of the natives of Macksburg resented the influx of oil men with the resulting disorder. A number of ministers attempted to control the lawlessness, but before much could be accomplished production decreased, and the oil men began to direct their attention on new areas. By 1900 Macksburg was once again a small country community.

GREATEST REGIONAL DEVELOPMENT, 1890–1903

With the rapid decline of production in the Macksburg field, the drillers began to explore the adjoining regions. In 1890 a wild-cat well was drilled near Sistersville in Monroe county at a locality known as Pole-Cat. A vast reservoir of brine was found in the Big Injun sand, and the well considered worthless, and left standing for 18 months. In 1891 another well was drilled nearby and started to produce from 10 to 15 barrels daily. This was the first producer of the Sistersville field, and opened one of the largest oil districts in southeastern Ohio. As other wells followed, oil was secured in all, but with a flood of brine. In 1892 it was decided to pump the Pole-Cat well with the hope of reducing the salt water and thus securing oil. About 3,500 barrels of brine per day were pumped for weeks. Finally, it began showing oil and gas; this steadily increased until 500 to 600 barrels of oil per day were produced. Attention was now focused on the Sistersville field. Drilling progressed rapidly, and some of the wells made as much as 1,200 to 1,500 barrels daily (Bownocker, 1903).

By 1892 oil in southeastern Ohio had been found in a sufficient number of places to bring the entire region under consideration. In the next ten years thousands of exploratory wells were drilled. Every township had at least one wild-cat well. Since most of the drilling was carried out on unproven territory the percentages of failures were high. From 1891 to 1899, 2,450 recorded wells were drilled; of this number 860 were dry holes, or 34 per cent of the total. The greatest amount of drilling was centered in Washington and Monroe counties, but there was also considerable drilling in Harrison, Jefferson, Belmont, and Noble counties.

During this period 37 major pools were discovered. Production continued to rise from 1890 until 1903 when the peak was reached. In that year approximately 4,200,000 barrels of Pennsylvania grade oil were produced (Fig. 2).

Along with the drilling in new areas, the Macksburg field and a number of the older pools again attracted attention. Most of the wells drilled in the 1880's into the Berea were drilled wet. The object of the casing, which usually extended 65 feet below the Macksburg 140 foot sand, was merely to prevent caving, and not to exclude water. The salt water was kept from the oil horizon by placing a packer around the tubing a few feet above the sand. This could not be removed, since the salt water above would at once enter the sand and cause a deposit of paraffin around the hole. Thus, when sand obstructed the hole in the bottom of the tubing, or the pores of the rock became closed the production of the well ceased though the oil was not exhausted. Redrilling began about 1895. The new wells were drilled dry, and by 1903 most of the older productive territory had been reworked. The majority of the wells started from 4 to 50 barrels, while formerly their initial production ranged from 10 to 400 barrels (Bownocker, 1903).

While many pools caused local boom conditions during the 1890's, none attracted more attention than Scio in Harrison county. The search for oil in this area began in the early seventies, but drilling at that time was too shallow to reach the pay horizons. The discovery of oil near Jewett in 1895 appears to have encouraged a renewed interest in the vicinity of Scio. Progress was slow, but by 1898 the Scio Oil and Gas Company was organized with a capital stock of $10,000. However, the people had little faith in the company and the stock did not sell rapidly. Even after the first producer little attention was paid to the oil industry.

The first well drilled to the Berea began to produce June 7, 1898, at 18 barrels per day. The second well was also a small producer, and on its completion was not pumped for several days, at the end of which time it began to flow. As a result, the gas caught fire from the boiler and burned the derrick. This accident was widely publicized, and as usual the production exaggerated. This attracted the attention of the oil men, and started a boom which in a short time revolutionized the village.

At the time of the discovery of oil, Scio had a population of about 900, composed largely of farmers and merchants. It had long been the favored spot of Methodist ministers who had gone there because of the advantage the Scio College offered their children. Only once in 18 years had there been a saloon in the town and it was driven out by the angry citizens. The discovery of oil made a complete change in the appearance of the town. The population by January, 1899, was over 12,000.

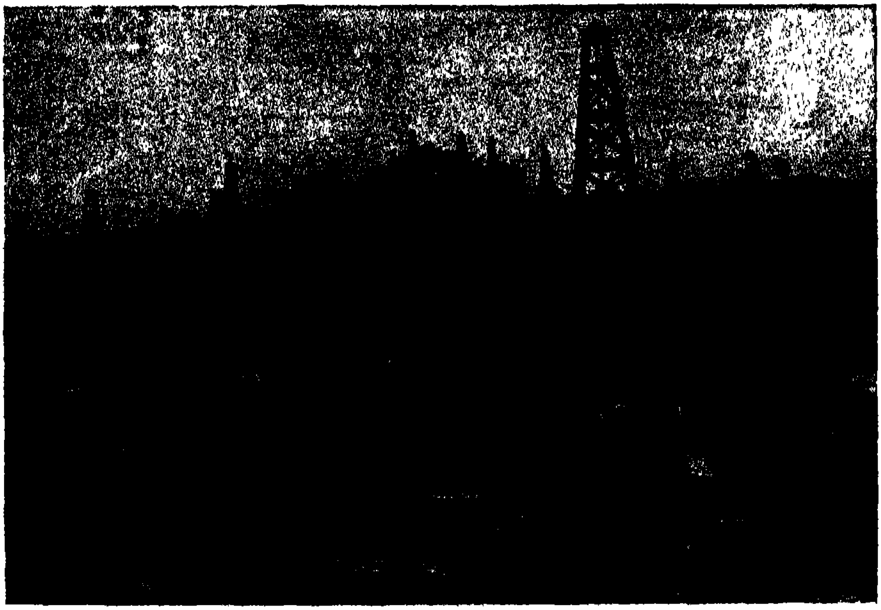


FIG. 3. Scio Oil Field during the Boom. (Courtesy of Ohio State Museum.)

"The village was unable to care properly for one-tenth of the people who had so suddenly gathered there. They lived in tents, shanties, reconstructed stables, boiler houses, or wherever they could find shelter. Many slept in chairs. Hundreds unable to find lodgings left on evening trains for nearby towns, returning the following morning" (Bownocker, 1903). There were eleven saloons in the town and an unknown number of "speakeasies." The barrooms and inns were a wild mass of teamsters, producers, workmen, speculators, mechanics, fakirs, gamblers, prostitutes, and hotel keepers all carrying on business and carousing. These features so horrified the staid citizens that many sold or rented their property and moved away.

Teamsters were in so great demand that frequently $40.00 a day was paid for their services. One operator reported having paid twenty dollars to have an ordinary boiler dragged sixty feet. The macadamized streets of the village were soon cut through and converted into mere mud channels. As the town grew, the fire hazard became greater so that insurance rates for choice locations were frequently as high as $100 per month. With the coming of oil the college almost disappeared. In eight weeks' time the attendance dropped from 300 to about 25, and all departments of the school except two were moved to New Philadelphia.

The time of greatest excitement occurred in the early months of 1899, when there were 75 strings of tools at work. After that a rapid decline set in, so that by 1900 the population had dwindled to about 1,200. Nevertheless, the village did not recede to its former condition, for an enormous amount of money was left in the community.

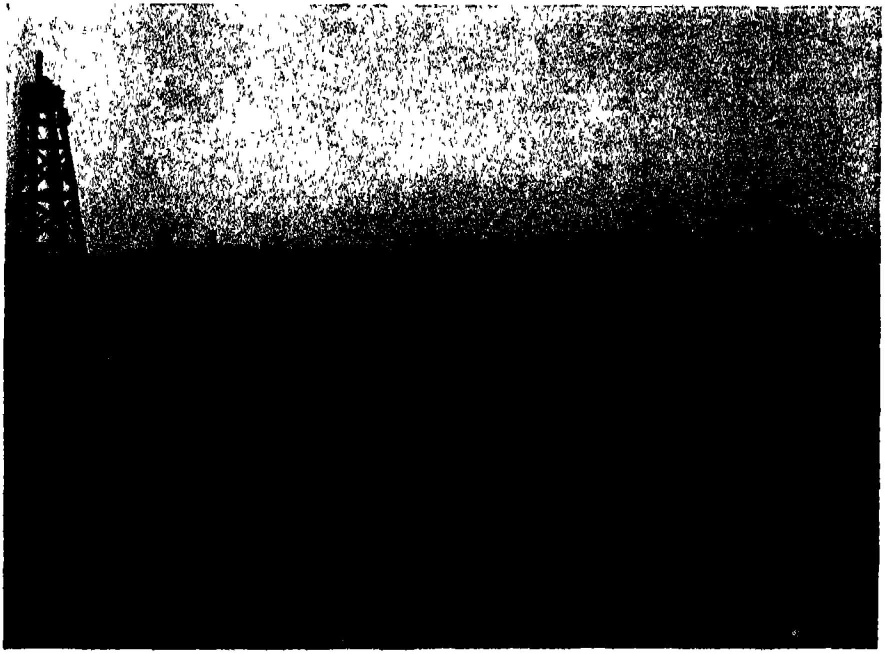


FIG. 4. Bishop Oil Field, Woodsfield, Monroe County, 1900.
(Courtesy of Ohio State Museum.)

The total number of wells drilled was about 1,000. Of these perhaps 220 were within the corporation limits of Scio. Bownocker (1903) states that from a financial viewpoint the village wells were failures because of their close spacing. At the height of the boom about 5,000 barrels of oil were produced per day, but by 1901 this had decreased to 300 barrels. Today the field is still producing in very small quantities.

PERIOD OF DECLINE, 1903–1942

Since 1903 there have been no important discoveries of oil in southeastern Ohio. The drilling policy has been to extend the limits of the fields and to maintain as stabilized production as possible. Drilling, as previously, has been most active in Washington and Monroe counties. The possibility of securing a gas well along with a small amount of oil has been the principal incentive for drilling during the past two decades. Production has declined uniformly at the rate of two to four per cent each year; so that the 1941 production was 1,176,000 barrels.

Southeastern Ohio was the scene of one of the first attempts of producers to increase the rate of production by secondary recovery methods. In 1903 a pioneer producer in the Macksburg field began to repressure using gas. After applying pressure for ten days, it was released and the well produced at a great rate. This procedure became known as the Smith-Dunn process.

In 1911 repressuring was again tried near Chesterhill in Morgan county. About 150,000 cubic feet of air per day was forced into one well at a pressure of 40 pounds, and within a week the production of the surrounding wells had increased (Schaefer, 1941). After the initial success at Chesterhill, the process soon spread to other areas. Lewis in 1917 stated that about 4,000 wells were affected by repressuring on more than 90 leases. It is estimated that approximately 80 per cent of the early projects were successful, and records from 32 properties show an average increase of three and one-half times the production from time repressuring began (Schaefer, 1941). Gas was used when available, but more than 90 per cent of the repressuring units used air.

At the present time the largest repressuring project in Ohio is located in the Sistersville field. The productive area is now approximately 10,590 acres. The wells very early in the life of the field were placed on vaccum pump, and as larger and more pumps were installed the vacuum was increased in 1910 and 1916. Just prior to the introduction of pressure in 1933 the vacuum over the entire pool was 25 inches (Schaefer, 1941). Approximately 1,500 wells were completed in the pool since 1892. There was originally one well to 6.84 producing acres, but because of many abandonments there is now one well to 17.7 acres. To the time of repressuring the average production per well was 13,450 barrels and a recovery of 1,965 barrels of oil per acre. There are now 374 producing wells in the field. Five operators control the production, and all have agreed to repressure as a unit operation. Gas is injected in fourteen old wells and five new ones. Each well has its own pressure plant. Injection pressures vary from eight to ten inches vaccum in the center of the pool to 100 pounds pressure on the northwestern edge (Schaefer, 1941). The average daily intake volume is from 100,000 to 150,000 cubic feet. In the beginning about ten million cubic feet of outside gas was used to establish the cycle. At present about three million cubic feet of gas is pumped daily, of which 1,600,000 cubic feet is returned to the sand. At the start of the gas injection in June, 1933, the average daily production of the pool was 124 barrels per day. This slowly increased and reached a peak of 337 barrels per day in March, 1939, a gain of about 172 per cent. Since that time a slow decline has set in.

At present there are eight repressuring projects in Washington, Morgan, and Monroe counties. The shallowness of the producing sands, the close spacing of the wells, and the low injection pressure required are the chief factors that favor repressuring. The greatest disadvantages are the lack of preliminary work done to determine the exact nature of the horizontal and vertical changes in porosity and permeability of the sand reservoir. There is also some difficulty in the by-passing of gas from the injection wells to the producing wells so that in certain cases the gas does not move through those areas that are still saturated with oil.

The possibility of water flooding as a means of secondary recovery has been considered in southeastern Ohio. The Berea formation has been successfully flooded in northeastern Ohio in Medina county. The Big Injun and Cow Run formations have high permeability and could be flooded. The greatest disadvantage to water flooding is that the average recovery per acre of petroleum in southeastern Ohio has been low. Therefore, water flooding recovery methods using new drilling would not be economically applicable in many places (O'Rourke, 1940). Financial success of flooding will depend largely on acquiring leases at a reasonable price that have had a satisfactory natural production. It has been estimated that with a spacing of one well to four acres, which will permit five rows of five inputs and four rows of four producers in each quarter-section, the cost of flooding will be (O'Rourke, 1940):

Depth	Cost per Acre
450 feet	$ 650.00
700 feet	1,100.00
1,200 feet	1,600.00
1,500 feet	2,000.00

One of the first horizontal wells in the world was drilled in southeastern Ohio. The process of horizontal drilling requires the sinking of a shaft to the oil sand and then drilling horizontally into the sand. Ranney (1941), the inventor of the process of horizontal drilling, states, "In the Ohio experiment six wells were drilled horizontally from a shaft in the First Cow Run sandstone. These three-inch wells were drilled in opposite pairs, half of them to property lines. While a 50-foot core was being pulled from one well, the drill rods (and duplicate tools) were being run into the opposite well. This was accomplished by a new machine, known as a 'rod puller,' which moves the rods at the rate of 100 feet per minute. The drill rods, in ten-foot lengths, were not disconnected until both wells were completed. In deep holes this cuts drilling time at least 75 per cent."

Horizontal drilling has a number of advantages over the usual method. It conserves steel, for horizontal wells require neither derricks, casing, nor tubing. The drilling of this type of well requires less than one-tenth of the power for the same length of sand exposed by vertical operations, and each shaft operating upwards of 400 acres exposes some 50,000 feet of producing oil sand. The greatest disadvantage to the extensive use of this method in Ohio is the initial cost. The total cost of shaft, equipment and two wells is about $75,000. At the present time the production from the Ohio horizontal well is about 2,000 barrels per year.

PRESENT CONDITIONS

The oil industry of southeastern Ohio has been suffering from depressed conditions for more than two decades. In 1939 the *Oil Weekly* reported that Ohio had the least return per dollar spent of all petroleum producing states. If both oil and gas were included for that year, there would have been a 75-cent return for each dollar spent. It is difficult to present actual costs of producing a barrel of oil in this section because of a lack of records for most leases, and in many instances producers' records are not kept under the desired classifications. The most recent attempt to consider production costs was made in 1941 when the Pennsylvania Grade Crude Oil Association prepared a brief for the Office of Price Administration. In order to obtain costs for the district, the most accurate method seemed to be to obtain from the producer the total "out-of-pocket" expense paid in connection with the given production. From the producer's total expense any amount paid for new drilling, new equipment of a capital nature, and interest on borrowed money were eliminated. A reasonable amount to represent compensation for personal services was included. To this was added the cost of depletion, depreciation, amortization, gas sales, and interest on investments as given for the past eight years by the Petroleum Administrative Board and the United States Tariff Commission. The total was then considered to be the total of the producer's operating and general overhead expense.

The data gathered covered eleven properties on which are located 1,630 wells. The total production of the wells was 147,534 barrels, which was thirteen per cent of the total for southeastern Ohio. It was found that it cost $2.70 for each barrel of oil produced in 1940. The costs were divided in the following manner: depletion, 14 cents; depreciation, 35 cents; amortization of intangible development costs, 27 cents; general expenditures, $1.83; interest, 30 cents; less 19 cents for the sale of gas. In 1940 the average price paid for the Pennsylvania grade crude of Ohio was $1.87. This crude was sold at a loss because it had to compete with areas of lower cost production.

Table I is a summary of production costs which shows the percentage of Pennsylvania grade oil that can be produced at or below 1940 costs in each of the producing states, i.e., Pennsylvania, New York, West Virginia, and Ohio. A special study was also completed by the Pennsylvania Grade Crude Oil Association to determine the percentage of crude that could be produced profitably from each of the districts at the market price of August 23, 1941. This was done by direct calculation of the costs for producing a barrel of crude oil. These percentages together with the market price of crude, the yearly production for each district for 1940, and the barrels of crude that can be produced without loss under the stated market price are shown in Table II. Multiplying the production of each

TABLE I

PERCENTAGE OF PENNSYLVANIA GRADE OIL PRODUCED BY STATES, AT OR BELOW COST SPECIFIED FOR THE YEAR 1940

	Pennsylvania	New York	West Virginia	Southeastern Ohio
Less than .40 per barrel	...	...	...	...
Less than .80 per barrel	...		...	...
Less than 1.20 per barrel	...	...	...	...
Less than 1.60 per barrel	9.87	...	...	...
Less than 2.00 per barrel	43.04	...	3.88	...
Less than 2.40 per barrel	53.69	38.00	8.12	49.10
Less than 2.80 per barrel	64.90	46.00	10.92	51.62
Less than 3.00 per barrel	79.77	59.00	58.30	55.16
Less than 3.20 per barrel	90.87	86.50	64.22	100.00
Less than 3.40 per barrel	94.31	92.30	97.37	...
Less than 3.60 per barrel	97.86	94.70	98.23	...
Less than 3.80 per barrel	98.41	96.00	98.63	...
Less than 4.00 per barrel	99.00	96.70	98.95	...
Less than 4.20 per barrel	99.06	97.00	98.95	...
Less than 4.40 per barrel	99.42	97.30	100.00	...
$4.40 and over per barrel	.58	2.70	...	...

TABLE II

	Crude Market 1941	Production Barrels per Year—1940	Per Cent and Barrels Which Can be Produced Without Loss Under Present Crude Market	
			Per Cent	Barrels
New York (Allegheny)	$2.75	3,462,120	45	1,557,954
Bradford	2.75	14,285,000	76	10,856,600
Kane to Butler	2.68	3,713,000	15	690,717
Pennsylvania (Comp.)	2.73*	...	63	...
West Virginia	2.34	3,400,000	4	137,760
Southeastern Ohio	2.30	1,176,000	24	282,240
		26,036,120	52	13,525,271

*Weighted price.

district by the percentage which can be produced at a profit gives the number of barrels that can be produced without loss. This shows that of the 1,176,000 barrels produced in southeastern Ohio in 1940 only 283,240 barrels, or 24 per cent, were marketed profitably.

However, it can be expected that this region will continue to produce at a gradually decreasing rate for many years. In 1941 the American Petroleum Institute estimated the Pennsylvania grade oil reserve of Ohio at 595,000,000 barrels. Of this amount 30,284,000 barrels are recoverable under present methods. Little or no allowance was made for secondary recovery methods; so it can be reasonably assumed that the actual recoverable reserve is twice the above figure, or 60,000,000 barrels. At the present rate of production this is approximately a 50-year reserve.

In spite of the fairly large recoverable reserve, the low price of oil has resulted in many abandonments, as illustrated by the following chart:

Year	Production	New Wells	Abandonments	Average Crude Prices
1938	1,161,000	72	1,105	$1 40
1939	1,160,000	70	823	1.60
1940	1,176,000	112	739	1.87
9 months 1941		121		

At the present time the junk value of wells is $800 to $1,000 and the need for steel will doubtless stimulate this trade unless a higher price for oil is obtained. Many producers find it preferable to salvage material and obtain cash rather than to continue production.

The increased demand, created by the present war needs, has stimulated new developments slightly. Production in 1941 increased approximately 500 barrels a day over that of 1940, and could be further increased. There was considerable development in older areas and wild-catting for new pools resulted in the discovery of the Clayton Perry Pool in Clayton township, Perry county. Its area is about 2,000 acres and is now producing at the rate of 1,400 barrels per day with an estimated total recovery of 3,000,000 barrels. Its area has not been completely defined, nor, due to the 3,200 foot depth and corresponding drilling costs, will there be substantial further development under conditions as they exist today. There are a number of areas which will be prospected for new pools with a rise in the market price, some cleaning out of old wells will be done, some new secondary recovery projects will help maintain or increase production, but for the immediate future the main increase in production will come from new areas and further development of the Clayton Perry Pool.

BIBLIOGRAPHY

1. **Andrews, M. R.** *History of Marietta and Washington County*, pp. 415–423. Biographical Pub. Co., Chicago, 1902.
2. **Bownocker, J. A.** *Oil and Gas*, Ohio Geological Survey, Fourth Series, Bull. 1, pp. 126–320, 1903.
3. ———. Rise and Decline in Production of Petroleum in Ohio and Indiana, Trans. Amer. Inst. Min. Met. Eng., 65: 1–12, Feb., 1920.
4. **Condit, D. D.** Structure of the Berea Oil Sand in the Woodsfield Quadrangle, Belmont, Monroe, Noble and Guernsey Counties, Ohio, U. S. Geological Survey, Bull. 626: 233–249, 1916.
5. ———. Oil and Gas in the Northern Part of the Cadiz Quadrangle, U. S. Geological Survey, Bull. 541: 9–17, 1912.
6. **Cottingham, K.** Structural Conditions in Portions of Eastern Ohio, Amer. Asst. Pet. Geol., 11: 945–958, 1927.
7. ———. Oil and Gas Developments in Ohio in 1940, A. I. M. E., Pet. Div., pp. 372–374, 1941.
8. **Hildreth, S. P.** *First Annual Report of the Geological Survey of Ohio*, pp. 62–63, 1838.

9. **Howe, Henry.** *Historical Collection of Ohio*, 2: 629–631. H. Howe and Co., Columbus, 1889–91.
10. **Lewis, T. W.** *Southern Ohio and the Muskingum Valley*, 1: 145–149, 253–259; 2: 93–99, 383–389, S. J. Clarke Pub. Co., Chicago, 1928.
11. **Lockett, J. R.** General Structure of the Producing Sands in Eastern Ohio in *Structure of Typical American Oil Fields*, (Amer. Asst. Pet. Geol.), 1: 138–147, 1929.
12. ———. An Outline Description of Producing Horizons in Eastern Ohio, (mimeographed pamphlet), 1942.
13. **Martin, F. M.** *State Centennial History of Ohio and Noble County*, pp. 114–120, S. A. Bryant Pub. Co., Madison, Wis., 1904.
14. **Minshall, F. W.** History and Development of the Macksburg Oil Field, Geological Survey of Ohio, Economic Geology, 6: 443–475, 1888.
15. **O'Rourke, E. V.** Lensing Sands of Ohio in *Stratigraphic Type Oil Fields*, (Amer. Asst. Pet. Geol.), pp. 382–385, 1941.
16. ———. Flooding in Ohio—Sand Characteristics—Well Spacing, Producers Monthly, 4: 22–28, June, 1940.
17. **Ranney, Leo.** Horizontal Wells are All in the Pay—and Flow by Gravity, Illinois-Indiana Petroleum Association, Ninth Annual Petroleum Conference, 1941.
18. **Rich, J. H.** Moving Underground Waters as a Primary Cause of the Migration and Accumulation of Oil and Gas, Econ. Geol., 16: 347–371, 1921.
19. **Schaefer, J. E.** Secondary Recovery in Ohio, Producers Monthly, 6: 11–15, April, 1941.
20. ———. Oil and Gas Development in Ohio in 1939, A. I. M. E., Pet. Div., pp. 353–357, 1940.
21. ———. Secondary Recovery Vital in Ohio Fields Operation, Oil and Gas Jour., 40: 59–60, April 24, 1941.
22. **Stout, Wilber.** An Historical Document of Interest to Petroleum Geologists, Amer. Asst. Pet. Geol., 22: 1687–1691, 1938.
23. **Summers, T. J.** *History of Marietta*, pp. 284–290, Leader Pub. Co., Marietta, 1903.
24. **Van Tassel, C. S.** *Book of Ohio*, pp. 710–727, Van Tassel Pub., Bowling Green, 1901.
25. **Verwiebe, W. A.** *Oil Fields in the United States*, pp. 65–81, McGraw-Hill Co., New York, 1930.
26. **Ohio**—Annual Review, Oil and Gas Jour., 39: 160, Jan. 30, 1941.
27. A Comprehensive Survey of Ways and Means of Increasing Crude Oil Production in Region No. 1, Producers Monthly, 6: 32–35, May, 1942.
28. Brief Presented by Pennsylvania Grade Industry at Hearings Before Office of Price Administrator, Producers Monthly, 6: 11–14, 34–37, Nov., 1941.

Bird Study and Ornithologists

Florence Page Jacques and her husband have here collaborated in producing a book that will be of considerable interest not only to ornithologists and experienced bird students, but to anyone who has ever thought of becoming interested in birds. The book deals principally with the author's relations to birds, bird trips, and ornithologists.

The author's experiences with bird study began with her marriage to Francis Lee Jaques, one of the foremost bird artists in the country and a member of the staff of the American Museum of Natural History. Her trips with her husband have taken her over much of this country (the back country of Minnesota, the waterfowl flyway down the Mississippi valley, the Appalachians and the Rockies) and parts of other countries (the Gaspe, England, Switzerland, and Panama), and behind the scenes at the American Museum of Natural History.

The author's general reaction to the field of bird study is summed up in her Preface: "When I first entered, I was entertained rather than sympathetic . . . but as I joined their activities my amusement changed to interest and then to joy. . . . This world is open to anyone, not merely those who have an innate love of birds. My knowledge has come slowly and even now my observation is far more joyful than scientific. But the deepening of insight and gradual knowledge has added infinitely to the richness of life." Reading the book, one feels with the author an increasing enthusiasm for the study of birds.

To the reader who knows the outstanding ornithologists of the country by name only, this book will give an intimate insight into their personalities. This reviewer will agree that these people are "some of the finest, the most delightful and inspiring people that I have had the good luck to know."

The colorful accounts of the author's trips and experiences, and the many excellent illustrations make this a very readable book, and one which will give some readers a new insight into the very interesting field of bird study.—*D. J. Borror.*

Birds Across the Sky, by Florence Page Jaques, with illustrations by Francis Lee Jaques. 1942. xii×240 pp. New York, Harper & Brothers. $2.50.

COMPOSITION OF FUNGUS HYPHAE IV: PHYTOPHTHORA[1]

R. C. THOMAS,
Ohio Agricultural Experiment Station,
Wooster, Ohio

The genus *Phytophthora* was established by de Bary (2). De Bary realized that there was a close relationship between the genera *Phytophthora* and *Pythium*, yet he considered that the difference in the germination of the sporangia of the species, known at that time, justified the separation.

In the germination of *Pythium*, it was observed that the contents of a sporangium first passed into a thin-walled vescicle, which later burst, freeing the spores. This was thought to be a specific characteristic of *Pythium*. As new species of *Phytophthora* were discovered, it soon became apparent that some of them displayed similar sporangial germination. Thus, the real differences between the two genera in morphology and cytology have become meager.

More recently, Fitzpatrick (3) has stated that there is no adequate reason for distinguishing *Phytophthora* from *Pythium* and that, in time, the two genera may be merged under the older name, *Pythium*, unless a more valid basis of differentiation can be established.

After the writer had completed a study of the composition of the hyphae of representative species of *Pythium* (8), attention was next directed to a similar investigation of a number of species which have been assigned to the genus *Phytophthora*. It was thought that such a comparative study might furnish further evidence either for merging *Phytophthora* and *Pythium* into one group, as suggested by Fitzpatrick, or for continuing them as two distinct genera of Phycomycetes.

In Dastur's (1) description of the species *Phy. parasitica*, an account of the composition of the mycelium is also included. He reports the presence of pectic-like material and cellulose. Tests for callose were negative, and chitin was not detected. Methods employed and viewpoints of analysis were considerably different 30 years ago from what they are now. In endeavoring to compare the reports of Dastur on *Phytophthora* with the more recent analysis of *Pythium*, by the writer, no adequate idea of similarities or differences of the two genera, can be obtained.

SPECIES INVESTIGATED

For the purpose of this investigation, the following species of *Phytophthora* were secured: *Phy. cactorum* (Leb. & Cohn) Schröt., *Phy. parasitica* Dastur, *Phy. infestans* (Mont.) de Bary, *Phy. capsici* Leon., *Phy. hydrophyla* Curzi, *Phy. pini* Leon., *Phy. cinnamoni* Rand, *Phy. melongenea* Swada, and *Phy. citrophthora* (Smith & Smith) Leon.

PLAN OF STUDY AND RESULTS

The species of Phytophthora used in this study, with the exception of *Phy. infestans*, grew well in potato broth. For this species, lima bean broth was substituted. In contrast to the *Pythiums*, the *Phytophthoras* made much slower growth. All of them formed mats more or less compactly interwoven, except *Phy. cinnamoni*, which developed a discrete colony type of growth without much interlacing. These colonies were fragile and could be broken apart readily. The same type of growth was displayed by *Phy. melongenea* during the first two or three weeks. Later the colonies grew together, forming a mat.

---

[1] Approved for publication by the Director of the Ohio Agricultural Experiment Station.

The same plan of analysis which had been found to be useful in determining the composition of other groups of fungi (6, 7, 8) was followed. Microchemical tests were used to direct the course of macrochemical procedure. Only qualitative methods were considered, and attention was directed entirely to the mycelium.

Some of the species of *Phytophthora* produced spores in potato broth; while others did not. Cultures varying in age from one week to three months were included in the study.

No difference could be detected between young and old cultures when the mycelia were observed in water mount in polarized light. Young cultures, three to four days old, and old cultures, three to four months old, were very dimly anisotropic, a condition which indicated the presence of callose or cellulose. When the hyphae were treated with a weak aqueous solution of ruthenium oxychloride, the dye was retained and could not be removed by prolonged washing in water. This characteristic of the mycelium, together with the absence of double refraction in polarized light, indicated the presence of pectic material on the outside.

Hyphae treated with Lugol's iodine solution followed by 70 per cent H_2SO_4 developed a blue color, which revealed the presence of cellulose. The presence of cellulose was confirmed with the aid of other cellulose reagents, such as $CaCl_2$-iodine, H_3PO_4-iodine, and LiCl-iodine (4). With some species of *Phytophthora* the blue color developed by the cellulose reagents appeared quickly; while in others the reaction was slow. In no case with fresh hyphae was there any swelling of the cellulose layer.

Information gained in these preliminary tests served as a guide for the procedure of analysis which was later formulated. It consisted in resolving the hyphae into component parts and identifying them.

Several fungus mats were cut into strips three to four millimeters wide, washed thoroughly to remove culture solution, then extracted for one hour in hot 0.5 per cent ammonium oxalate. The liquid was filtered off, and an equal volume of 95 per cent alcohol added. A finely divided precipitate appeared, which after a time settled to the bottom of the flask. A second extraction removed a smaller amount of material and a third none. The precipitates from the ammonium oxalate extractions were collected on a fritted glass filter, washed with alcohol, then taken up in a small quantity of water. When the Molisch test was made, a violet color appeared, indicating that a condensation product between alpha-naphthol and furfural was formed. A faint pink to brownish color developed when the orcinol-HCl reaction was applied. When a drop of $FeCl_3$ solution was added, a brilliant green color promptly resulted. The green color could be entirely removed by shaking with amylic alcohol. Pectic compounds could not be demonstrated as pectic acid by the addition of concentrated HCl or as calcium pectate with $CaCl_2$. When hydrolyzed with H_2SO_4 the product reduced Fehling's solution. The material removed with the ammonium oxalate extraction was not pectic compounds but was probably a mixture of pentose and hexose anhydride, as indicated by the orcinol HCl-$FeCl_3$ reaction.

With the outside covering removed, the mycelium did not permanently retain the ruthenium oxychloride dye, but it did stain with methylene blue. Extraction was next made with ammoniacal cupric hydrate sufficiently strong to dissolve cellulose promptly. When the liquid was filtered off and neutralized with HCl, a copious precipitate appeared. This was found to be isotropic when examined in polarized light, yet it gave a positive reaction when tested with cellulose reagents.

Further extraction with ammoniacal cupric hydrate removed nothing. The mycelium was still dimly anisotropic as at first and did not fix dyes. This inert character of the hyphae was suspected to be due to the presence of fatty acids.

Refluxing in 2 per cent alcoholic potash saponified the fatty acids in the outer portion of the hyphae with a result that the blue color appeared more quickly when the cellulose reagents were applied, and when the mycelium was again extracted with the cellulose solvent more material went into solution. It was necessary to repeat the process of saponification of fatty acids followed by extraction with ammoniacal cupric hydrate at least once, and in some instances, twice, before all the cellulose was removed. All the cellulose of *Phy. cinnamoni* could be removed without saponification of fatty acids.

The cellulose precipitates were collected on a glass filter, thoroughly washed, dried, and then suspended in 10 cc. of 17.5 per cent NaOH. The hydrate was allowed to act for 30 minutes with occasional stirring. The solution was then diluted with an equal volume of water and filtered through a glass filter. Part of the cellulose dissolved in the alkali and part did not. The residue was washed with 20 cc. of 8 per cent NaOH, then with water, followed with 1 per cent acetic acid, and finally with water until all free acid was removed. The portion which did not dissolve was found to be doubly refractive in polarized light, whereas the portion which was recovered from the extract by neutralizing the alkali was not doubly refractive. Both precipitates readily gave a blue color with cellulose reagents, and upon hydrolysis yielded reducing sugars. Tests for proteins were negative. It was concluded that two forms of cellulose were present: the alpha (5) form, which did not dissolve in the alkali, and another form, which did dissolve and could be recovered.

At this stage of the analysis, the walls of the hyphae were still intact. When viewed in polarized light they were isotropic, developed a brown color with cellulose reagents, and did not fix aniline dyes. The residue was proved to be chitin by a positive chitosan reaction. No callose or structural proteins were detected.

COMPARISON OF MYCELIUM OF PHYTOPHTHORA AND PYTHIUM

Very young *Pythium* hyphae are isotropic when observed with a polarizing microscope. This condition is due to a layer of pectic compounds on the outside. When this layer is removed, the anisotropic cellulose becomes visible. The pectic material is used up and disappears after five to seven days as the hyphae reach maturity, leaving the cellulose the outside layer.

Phytophthora hyphae present a dimly anisotropic appearance at all stages of growth. There is no true pectic layer on the outside. When the covering is removed, the mycelium presents the same appearance as at first, and at no time can the cellulose be made brightly anisotropic. Furthermore, two forms of cellulose were detected in *Phytophthora*.

In view of the biochemical differences which exist between these two supposedly closely related genera of fungi, it becomes evident that in the location of a new species, consideration might properly be given to the structure of the hypha to determine whether it conforms to the general pattern of the genus to which the species appears to belong. Previous studies by the writer have shown that there is a close conformity in mycelial structure among species of a genus.

SUMMARY

An investigation of nine different species of *Phytophthora* has been made in order to determine the composition and structural pattern of the mycelium. A basic skeleton of chitin was found to have superimposed upon it a mixture of two forms of cellulose, one of which was doubly refractive in polarized light and the other was not. These were impregnated with fatty acids. It was necessary to saponify the fatty acids with alcoholic potash before the cellulose could be removed by solution in ammoniacal cupric hydrate.

The outside layer was found to be a carbohydrate mixture which gave the

orcinol-HCl test for pentoses. The presence of a hexose was also indicated. No pectic compounds were present.

When viewed in polarized light, the same appearance is presented by young and old cultures of typical species of *Phytophthora*. In this respect there is a marked contrast between the two groups of fungi, *Phytophthora* and *Pythium*.

REFERENCES

(1) **Dastur, J. F.** 1913. On *Phytophthora parasitica*, nov. spec. A new disease of the castor oil plant. Mem. Dept. Agric. India. Botanical Series 5: 177–231.

(2) **de Bary, Anton.** 1860. Sur la formation de zoospores chez quelques champignons. Ann. Sci. Nat. (4 ser.) 13: 236–251.

(3) **Fitzpatrick, Harry M.** 1930. The lower fungus Phytomycetes. 331 pp. First edition. McGraw-Hill Book Company.

(4) **Post, E. E., and J. D. Laudermilk.** 1942. A new microchemical reaction for cellulose. Stain Technol. 17: 21–24.

(5) **Schorger, A.** 1926. The chemistry of cellulose and wood. pp. 596. First edition. McGraw-Hill Book Company.

(6) **Thomas, R. C.** 1928. Composition of fungus hyphae I: The Fusaria. Amer. Jour. Bot. 15: 537–547.

(7) ———. 1930. Composition of fungus hyphae II: Sclerotinia. Amer. Jour. Bot. 17: 779–788.

(8) ———. 1942. Composition of fungus hyphae III: The Pythiaceae. Ohio Jour. Sci. 42: 60–62.

Plant Communities of the Welaka Area, Florida

This bulletin contains detailed descriptions of twenty-four plant communities which occur in the Welaka area, Putnam County, Florida, the 2,180 acre tract comprising University of Florida's Conservation Reserve. The communities are classified by the author into seven types, and are carefully described on the basis of aspect, floristic composition, structure and extent. The association described include every primary type in the area, and the communities occupying abandoned fire lanes, lawns, ditches and roads are also discussed. An attempt has been made to analyze the successional relationships and some correlation with eight soil types is recognized. Climatic data are given but were not obtained in the plant habitats of the problem area. A list of 750 species of plants growing in the area make up twenty-eight tables, in which the abundance or rank of each species for each community is indicated, and vegetation maps and twenty-eight photographs are included.—*J. N. Wolfe.*

The Plant Communities of the Welaka Area. A. M. Laessle. 143 pp. Univ. of Fla. Publication, Biological Science Series. Vol. IV, No. 1. July, 1942. $1.50.

Physics and Philosophy

Readers familiar with the recent development of theoretical physics, in particular with relativity and quantum theory, will enjoy this book very much as a colorful supplement to their dry formulas and equally dry experiments. It remains doubtful, however, whether the sparkling style, the many striking similes and puns will satisfy those readers who look for information concerning the philosophical problems of our sources of knowledge, determinism versus free will, space and time, etc., in their relation to modern physics. Jeans' representation remains too much on the surface as to seriously touch the problems of present day philosophy, although his criticism of medieaval and antique philosophers and their verbal struggles is very striking. One cannot refrain from the observation that being a great physicist does not imply being a good philosopher, too. Nevertheless it is always instructive and entertaining to read what an original thinker has to say about any subject matter whatsoever, even if his exposition is only "popular" in the best sense of the word.—*Alfred Landé.*

Physics and Philosophy, by Sir James Jeans. 222 pp. Macmillan Company, New York, 1943. $2.75.

SOME INVESTIGATIONS OF THE WATER RELATIONS OF LICHENS[1]

HERBERT T. SCOFIELD and LAWRENCE E. YARMAN
The Ohio State University, Columbus, Ohio

At intervals during the summers of 1941 and 1942 the writers collected samples of lichens at various times of day from a southwest facing sandstone cliff in Hocking County, Ohio, and measured the water content. The purpose of these periodic measurements was to find out when water absorption occurred, where the water came from, and when it was lost. Concurrent measurements of the humidity of the air adjacent to the plants and of the temperature of the air and plants were made with a view toward possible correlation of these data with the moisture data.

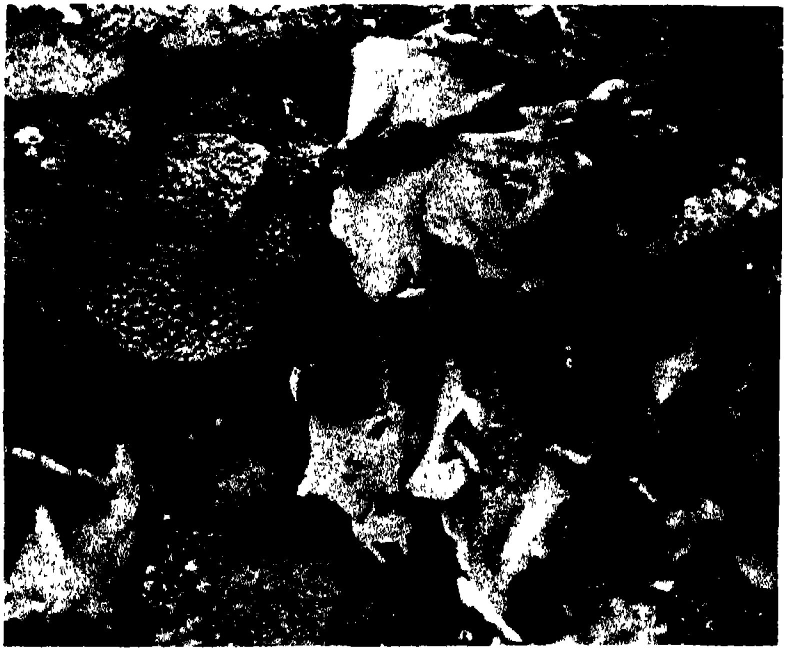


FIG. 1. *Gyrophora dillenii* (right center) and *Umbilicaria pustulata* (left center), about one-half natural size.

The lichens chosen for investigation were *Gyrophora dillenii* (Tuck.) Mull. Arg. and *Umbilicaria pustulata* (L.) Hoffm. (Fig. 1). These lichens occur together on the Blackhand sandstone cliff walls of Neotoma, a tributary valley of Clear Creek, Hocking County, in sufficient numbers to permit such an investigation. Gyrophora is a large leathery lichen, dark greenish brown above with a black felt-like mass of rhizoids beneath. The plant is attached to the rock substrate by a short tough umbilicus. Umbilicaria is a smaller thinner lichen than gyrophora, light brown in color with wart-like pustules above and no rhizoids beneath. The plant is also fastened to the substrate by a short umbilicus.

---

[1] Papers from the Department of Botany, The Ohio State University, No. 460.

Experimental data concerning the water relations of lichens are not numerous and are of limited pertinence to our problem. It has been recognized that most lichens do not normally contain much water, that some specimens when moistened attain fresh weights three to four times their dry weights, and that probably some species living in desert and other arid habitats are dependent on the atmosphere and dew for available water. Smith (1921), in a review of the literature to that time, reports that lichens can endure almost complete desiccation during long drought periods. They absorb water over their entire surface and water may be held for some time by rhizoids and gradually absorbed. Heugebauer (1939) studied the water relations of several species of *Parmelia* and of *Usnea dasypoga* and reported differences in rates of water loss and in total amount of water held. Lundegardh (1931) suggests that on naked rock surfaces only small slowly growing plants such as algae and lichens can withstand the periodic desiccation. Weaver and Clements (1938) assert that lichens flourish during periods of wet weather and remain in a state of desiccation for very long periods during drought.

MATERIALS AND METHODS

Samples of lichens were collected in the field, placed in glass bottles with plastic screw-caps, and transported as soon as possible to the laboratory for fresh weight and 103° C. oven-dry weight determinations. Water content is expressed as per cent of the oven-dry weight. It was recognized that some non-uniformity in water content among plants in the same general habitat would probably exist and care was taken to reduce this sampling error by taking large samples consisting of small pieces from many plants. Statements about the water content of intact plants at any particular time are based on samples taken at that stated time. Humidity determinations were made with a Friez aspirating psychrometer. Temperature measurements were made with a Leeds and Northrup portable potentiometer and copper-constantan thermocouples inserted into the lichens or exposed to the air.

FIELD EXPERIMENTS

The first experiment consisted of taking samples of both plants at intervals for a twenty-four hour period. The data are shown in Table I.

TABLE I

DATA OF JUNE 28–29, 1941

SOLAR TIME	PER CENT WATER		TEMP. IN °C.	
	Umbilicaria	Gyrophora	Air	Lichen
1:30 P. M	18.7	18.6	34.4	32.5
3:30 P. M.*	123.1	365.0	27.2	33.2
5:30 P. M	37.9	50.1	28.2	32.5
5:30 A. M	56.9	53.3	22.8	25.5
9:30 A. M	58.3	44.9	28.6	30.0
11:30 A. M	28.2	17.9	31.4	38.0
1:30 P. M	24.0	13.6	28.3	32.0

*Thunder-showers of 0.2 in. between 2:10 P. M. and 2:50 P. M.

The high water content of the samples following the forty minutes of thunder-showers and the rapidity with which much of the water was lost as evidenced by the succeeding samples should be noted. Later laboratory work showed that the water content of gyrophora plants in equilibrium with a saturated atmosphere at

30° C. was 92 per cent. Hence much of the water in the gyrophora plants at 365 per cent water content must have been loosely held on the plant surfaces, not absorbed internally, and evaporated rapidly from the plants. The rhizoids of gyrophora would hold much more water on the surface of the plant than would be held in umbilicaria.

For comparison with Table I, data obtained at a later date are presented in Table II. No rain had fallen in the valley for several days prior to the date of collection.

TABLE II

DATA OF JULY 5–6, 1941

SOLAR TIME	PER CENT WATER		VAPOR PRESSURE	TEMP IN °C.	
	Umbilicaria	Gyrophora		Air	Lichen
4:30 A. M.	112.3	85.4	12.5	18.3	20.0
10:30 A. M.	44.6	46.3	17.5	23.9	25.0
1:30 P. M.	25.3	25.3	17.5	25.8	28.5
4:30 P. M.	16.3	17.4	18.5	28.3	36.5
4:30 A. M.	100.4	74.3	15.5	19.4	24.0
7:30 A. M.*	113.2	82.1	16.5	19.7	23.0

*Light rain falling.

The evidence of considerable increase in water content in the absence of rain during the night hours should be noted. In all other experiments performed which included samples taken at night, evidence of increase in water content during the night was obtained. These findings indicate that extreme drought periods during the summer in this region are limited for these plants to some of the daylight hours. Results of several nights collections at one hour intervals showed no regularity in the rate of water absorption and no uniformity in the amount of water absorbed from night to night.

In an effort to determine whether the water absorbed at night came from the rock substrate or the atmosphere, several experiments were performed with gyrophora plants. Initial samples were taken in the afternoon. At the same time some specimens were detached from the rock, mounted on paraffined papers, and the papers fastened to the rock surface. The next morning, samples were taken of intact and paper mounted plants. Table III summarizes the data. Station A was a more exposed and higher place on the cliff wall than Station B.

TABLE III

SOLAR TIME, DATE AND SAMPLE	PER CENT WATER, GYROPHORA	
	Station A	Station B
2:30 P. M. June 25, 1942, initial sample	22.0	
4:50 P. M. June 25, 1942, initial sample		25.0
4:30 A. M. June 26, 1942, final samples—intact	34.0	39.0
paraffined paper	42.0	35.0
4:30 P. M. August 15, 1942, initial samples	17.0	21.0
4:45 A. M. August 16, 1942, final samples—intact	27.0	30.0
paraffined paper	32.0	37.0

Humidity and temperature measurements during the course of the experiments showed that no dew point temperatures were reached at the plant surface or in the air adjacent. No other visual evidence of dew was noted at points that high above the valley bottom. Since both intact and detached plants mounted on paraffined papers absorbed water overnight in fairly comparable amounts it seems likely that the increase in water content during the night hours was due to the imbibition of water vapor into the plants.

The data of Tables I and II indicate a reduction in water content of these lichens during the daylight hours. Visual and physical evidences of this fact have been experienced by the writers in the field many times. Both plants commonly become brittle and gyrophora curls so that the lower surface is exposed (Fig. 1). More detailed data from an experiment with gyrophora plants that were collected from a tree-shaded habitat dominated almost entirely by this species are presented in Table IV. In Table V are similar data for umbilicaria plants collected from a cliff top station somewhat shaded by a pine tree. These latter plants were collected on what proved to be the hottest day in three summers. Table VI is included to show the water content of umbilicaria plants fully exposed to solar radiation during the warmest part of that day.

TABLE IV

DATA OF JULY 22, 1941

SOLAR TIME	PER CENT WATER GYROPHORA	VAPOR PRESSURE	TEMP IN ° C.	
			AIR	LICHEN
4:30 A. M	33.9	11.5	15.6	22.5
5:30 A. M	26.0	11.5	15.6	23.0
6:30 A. M	33.2	11.5	15.6	22.5
7:30 A. M	31.8	13.0	17.5	22.0
8:30 A. M	28.9	15.0	20.3	24.5
9:30 A. M	29.6	14.5	20.6	25.5
10:30 A. M	18.9	17.5	23.9	28.0
11.30 A. M	17.5	16.0	24.4	28.0
12:30 P. M	18.6	15.5	25.0	28.5
1:30 P. M	18.2	16.0	26.1	28.0
2:30 P. M	17.0	15.5	25.3	28.5
3:30 P. M	16.1	16.5	24.7	27.5
4:30 P. M	17.6	17.5	23.6	27.5

The water content of both lichens decreased during the morning and early afternoon hours due to the diffusion of water vapor from the plants. Calculations of the adjacent atmospheric vapor pressures from psychometric data show a small increase in atmospheric vapor pressure during those hours. The vapor pressure of water in the lichens, then, must have been increasing to an even greater extent than that of the atmosphere or transpiration could not have occurred during those hours. However, as the water content of the plants decreased, the degree of hydration of the plant material should decrease and the vapor pressure decrease to a point approaching that of the atmosphere. One must account for an increase in vapor pressure of the water in lichens whose water content is decreasing. The temperature data show that the temperature of the lichens was commonly higher than that of the air adjacent; this fact would seem to bear a casual relationship to extended periods of water loss from the plants. The data of Table V and Table VI indicate that the more exposed the plants to direct solar radiation, the higher the plant temperature and the lower the water content. In all of the field work in which samples were taken from several regions of the cliff wall at the same time, the lowest water contents were found in the plants exposed to direct solar radiation. The high plant temperatures existing under such conditions would account at least in part for high plant vapor pressures and steeper vapor pressure gradients between plant and atmosphere, and hence for lower water contents.

TABLE V

DATA OF JULY 26, 1941

SOLAR TIME	PER CENT WATER UMBILICARIA	VAPOR PRESSURE	TEMP. IN °C.	
			Air	Lichen
4:30 A. M	24.8	16.5	21.7	25.5
5:30 A. M	29.0	18.0	22.2	27.0
6:30 A. M	20.6	18.0	22.8	27.0
7:30 A. M	22.5	18.5	25.0	27.0
8:30 A. M	18.7	20.5	27.2	30.5
9:30 A. M	18.1	21.5	29.4	34.0
10:30 A. M	16.4	23.5	30.0	39.0
11:30 A. M	12.7	22.0	28.9	39.5
12:30 P. M	13.0	23.0	30.6	42.5
1:30 P. M	11.3	23.5	35.0	42.5
2:30 P. M	11.4		35.6	38.5
3:30 P. M	10.7	...	35.3	36.5
4:30 P. M	10.6	24.5	32.8	33.5

TABLE VI

DATA OF JULY 26, 1941

SOLAR TIME	PER CENT WATER UMBILICARIA	VAPOR PRESSURE	TEMP. IN ° C.	
			Air	Lichen
12:30 P. M	8.4		43.5	45.0
1:30 P. M	6.5	...	40.0	48.5
2:30 P. M.	6.4		43.0	50.5
4:30 P. M	7.8	...	39.0	44.0

DISCUSSION

Evidence of marked diurnal fluctuations in water content of these lichens has been presented. Precipitation water or condensation water may be imbibed by these plants and even held by capillarity. The data show, however, that water absorption of some magnitude may occur between periods of precipitation or condensation. The writers' opinion that the direction and rate of water vapor diffusion will explain fluctuations between rains is supported by the experimental results. The factors of greatest importance in determining the direction and magnitude of vapor pressure gradients between these plants and the atmosphere are temperature differences between plants and atmosphere, and changes in the degree of hydration of the plant tissue as they may affect the vapor pressure of water in the plants.

If an imbibition-transpiration mechanism of the water relations of these lichens is valid, it should be possible to predict changes in water content under controlled conditions. Atmospheres of known vapor pressure may be obtained over sulphuric acid solutions of known density and temperature. Lichens with vapor pressures higher than that of a given atmosphere should lose water to that atmosphere until an equilibrium is established. Lichens with vapor pressures lower than that of a given atmosphere should imbibe water vapor until an equilibrium is established.

Gyrophora plants were brought from the field into the laboratory and samples suspended over sulphuric acid solutions of varying density at constant temperature. By using a large ratio of sulphuric acid solution to plant material and air space, the changes in density of the acid due to loss or gain of water were small. The relationship between the equilibrium vapor pressures and the water contents of the lichen samples is shown in Figure 2. The curved line would represent the path of change in water content of a given sample of gyrophora plants in equilibrium with a saturated atmosphere as it came into equilibrium with sulphuric acid solutions of increasing density and decreasing vapor pressure. The shape of the curve indicates that water above 30% water content is held very loosely and small changes in the equilibrium vapor pressure result in large changes in the percentage water content. At water contents below 30% in this experiment, the water is held more tightly and large changes in the equilibrium vapor pressure result in relatively small changes in the percentage water content.

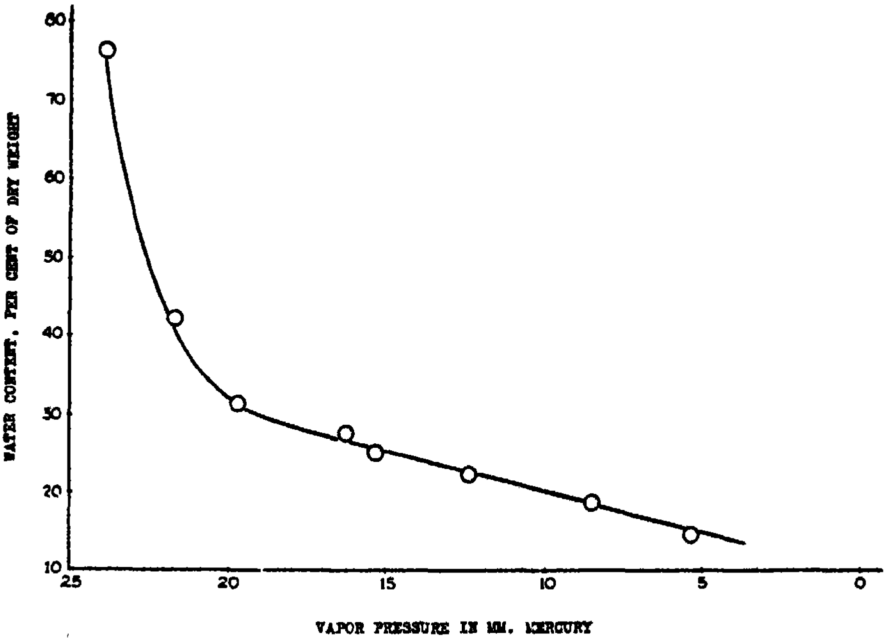


FIG. 2. The water content of samples of *Gyrophora* in equilibrium with sulphuric acid solutions of known vapor pressure at 24° C.

The results of the experiment substantiate the idea of imbibition of water vapor by these plants and transpiration from them. Attempts to utilize this method to estimate the actual vapor pressures of water in plants in the field by finding the vapor pressure at which no change in weight of the sample occurred, met with technical difficulties. Obviously the temperature of the plants at the time of collection would have to be known and kept constant in order to keep the vapor pressure constant. The temperature of the sulphuric acid solutions would have to be carefully regulated to that of the plants in the atmosphere above. Errors due to uncontrollable variations in these last mentioned factors were too great to make the method useful in the field.

A laboratory experiment was performed to test the influence of solar radiation on the rate of water loss from water saturated plants on the final equilibrium water content. Gyrophora plants were soaked in water for several hours and then suspended in air until water ceased to drip from them. They were spread out on a laboratory table and their fresh weights determined at regular intervals until they reached constant weight. The oven dry weight of the plants was then determined and the fresh weights converted to per cent of water on a dry weight basis. A similar experiment was performed with gyrophora plants spread out on a glass plate on the ground outside the laboratory and exposed to solar radiation. The data are presented as drying curves in Figure 3. The slope of the curves indicates relative rates of water loss and the final equilibrium water contents are apparent as the curves flatten out parallel to the abscissa. The influence of solar radiation is apparent on inspection and in agreement with field data.

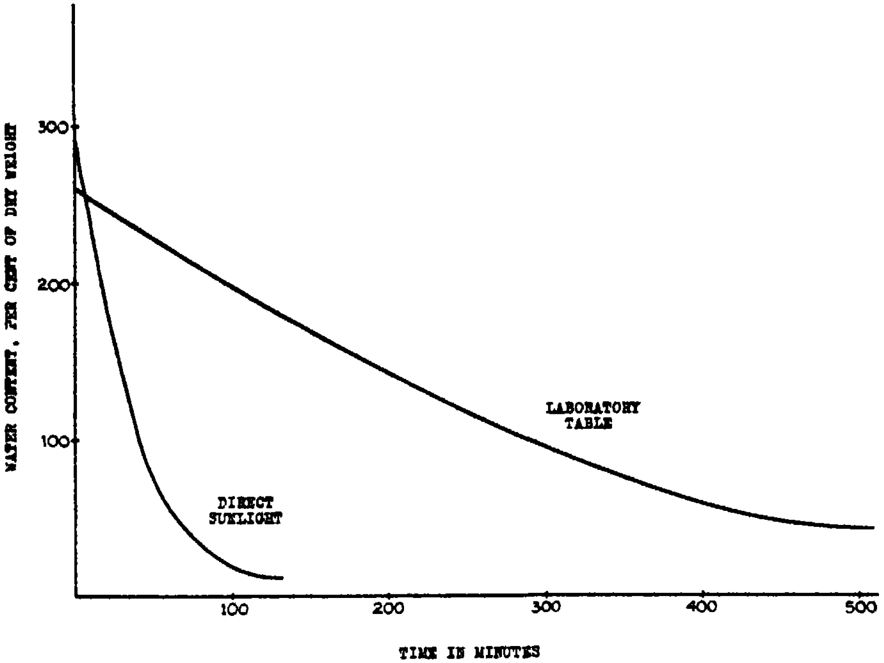


FIG. 3. Drying curves of *Gyrophora* samples indoors on a laboratory table and out-of-doors in direct sunlight.

SUMMARY

Field experiments were performed with two species of lichens growing on the southwest facing cliff, walls of a valley in Hocking County, Ohio. Data on the percentage water content on a dry weight basis, plant and air temperatures, and atmospheric humidity were obtained at various intervals during two summers.

The results of these experiments indicate that these plants do not remain in a state of desiccation during periods between rains or dew, but exhibit a marked diurnal fluctuation in water content. During the daylight hours, particularly in clear weather, the water content decreases due to transpiration. Extended periods of transpiration are possible because the temperature of the plants was found to be commonly higher than that of the air adjacent, especially if exposed to solar radiation. Such temperature differences would cause the occurrence of a vapor pressure gradient from plants to atmosphere even at low water contents of the plants. During the night hours, imbibition of water vapor into the lichens occurs whenever the vapor pressure gradient is from atmosphere to plants. Such a condition may exist when plants at low water content become cooled at night to a temperature close to that of the atmosphere.

Laboratory experiments were performed and the results substantiate the fact that these lichens may gain water vapor by imbibition and lose water vapor by transpiration. The effect of solar radiation on increasing the rate of transpiration and lowering the final equilibrium water content was also demonstrated.

The writers wish to express thanks to Edward S. Thomas, on whose property the experimental work was performed, and to John N. Wolfe and Fred H. Norris for helpful suggestions and assistance.

LITERATURE CITED

1. **Heugebauer, Hans F.** 1938. Zur Okölogie von in Buchenkronen eiphytisch lebenden Flechten. Beitr. Biol. Pflanzen 25: 273–289. (Biol. Abst. 13: No. 3504. 1939.)
2. **Lundegardh, Henrik.** 1931. Environment and plant development. p. 163. Edward Arnold & Co.
3. **Smith, Lorrain Anne.** 1921. Cambridge Botanical Handbooks. Cambridge University Press.
4. **Weaver, John E. and Frederic E. Clements.** 1938. Plant Ecology. pp. 66–68. McGraw-Hill Book Co., Inc.

Monograph on Florida Crayfishes

This publication has grown out of ten years work on Florida crayfishes by Horton H. Hobbs, Jr. The data presented are based upon a collection of over ten thousand specimens collected by himself and colleagues of the University of Florida.

In the first twenty-two pages the author discusses the comparatively recent spread of crayfish stock into Florida, the ecological highways and barriers to migration; also the development of endemic races and species. The remaining pages are occupied by taxonomic descriptions, distribution maps and figures of forty-two Floridian Cambarinae. Twenty-five of these are now regarded as endemic to the state and six of the twenty-five are cavernicolous forms.

—*Wilbur M. Tidd.*

The Crayfishes of Florida, by Horton H. Hobbs, Jr. Pages v and 179, 24 full plates and 346 figures. Published by the University of Florida, Vol. III, No. 2, November, 1942. Paper bound. Price $2.25 plus postage.

Outlines of Entomology

The author, who needs no introduction, presents in a clear, concise and scientific manner the fundamentals of the subject of entomology. The book is intended for students of Zoology who desire a broader training in the subject than that which is usually given in such courses. It is primarily morphological, physiological, and taxonomic in character and the subject matter covered is as follows: Introduction; The Integument and its Derivatives; Segmentation and the Body Regions; Sense Organs; Nervous, Muscular, Respiratory, Circulatory, Digestive, Excretory and Reproductive Systems; Embryology, Growth and Metamorphosis; Nomenclature and Classification; Relationships of Insects; Bibliography; Index.

The information is authentic in every detail and the reader will marvel at the wealth of information in a book of its size.—*R. H. Davidson.*

Outlines of Entomology, by A. D. Imms. 184 pages, 96 illustrations. E. P. Dutton and Company, New York. 1942. $3.75.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIII JULY, 1943 No. 4

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE 1943

THE OHIO ACADEMY OF SCIENCE

Organized 1891 Incorporated 1892
Affiliated with the American Association for the Advancement of Science

OFFICERS AND COMMITTEES FOR 1943–1944

President

H. C. SHETRONE

Vice-Presidents

A. *Zoology:* H. R. EGGLESTON
B *Plant Sciences:* FREEMAN S. HOWLETT
C. *Geology:* JOHN W. WELLS
D. *Medical Sciences:* E. W. E. SCHEAR
E. *Psychology:* A. C. ANDERSON
F. *Physics and Astronomy:* E. H. JOHNSON
G. *Geography:* C. C. HUNTINGTON
H. *Chemistry:* H. J. GARBER
I. *Mathematics:* R. E. MANCHESTER
J. *Junior Academy:* PHILIP DYE
K. *Anthropology:* WILLIAM LIPKIND

Secretary

A. W. LINDSEY

Treasurer

CLARENCE E. TAFT

Historian

WILLIAM H. ALEXANDER

Executive Committee

Ex-Officio: H. C. SHETRONE, A. W. LINDSEY AND C. E. TAFT
Elective: EUGENE VAN CLEEF AND GLENN W. BLAYDES

Trustees of the Research Fund

HERBERT OSBORN, *Chairman*, term expires	1944
F. C. BLAKE, term expires	1945
M. E. STICKNEY, term expires	1946

Library Committee

Mrs. Ethel M. Miller, *Chairman*

Librarian in charge of Academy Exchanges and Publications

Warren P. Spencer, term expires	1944
William Lloyd Evans, term expires	1945

*Committee on Conservation**

G. W. Conrey, term expires	1944
Paul B. Sears, term expires	1944
E. L. Wickliff, term expires	1944
E. Lucy Braun, term expires	1945
E. S. Thomas, term expires	1945
Wilber Stout, term expires	1945
Roscoe W. Franks, term expires	1946
T. H. Langlois, *Chairman*, term expires	1946

Committee on Nominations for 1943-1944

The Vice-Presidents of 1942-1943—Robert M. Geist, *Chairman*

Membership Committee for 1943-1944

A. *Zoology:* Marion Boesel, *Chairman*
B. *Plant Sciences:* W. E. Steidtmann
C. *Geology:* H. A. Ireland
D. *Medical Sciences:* L. F. Edwards
E. *Psychology:* Arthur G. Bills
F. *Physics and Astronomy:* C. W. Jarvis
G. *Geography:*†
H. *Chemistry:* R. G. Bossert
I. *Mathematics:* E. I. Yowell
J. *Junior Academy:* Nelson Crites
K. *Anthropology:* Richard G. Morgan

Academy Representatives

1. On the Joint Administrative Board of the Ohio Journal of Science:

Warren P. Spencer, term expires	1944
William Lloyd Evans, term expires	1945

2. On the Council of the A. A. A. S.: A. W. Lindsey.
3. On the Save-Outdoor-Ohio Council: Roscoe W. Franks.

The Council for 1943-1944

Anderson, A. C.
Bills, Arthur G.
Blaydes, Glenn W.
Boesel, Marion
Bossert, R. G.
Crites, Norman
Dye, Philip
Edwards, L. F.
Eggleston, H. R.
Evans, William Lloyd
Garber, H. J.
Howlett, Freeman S.
Huntington, C. C.
Ireland, H. A.
Jarvis, C. W.
Johnson, E. H.
Krecker, F. H.
Langlois, T. H.
Lindsey, A. W.
Lipkind, William
Manchester, R. E.
Miller, John A.
Morgan, Richard G.
Osborn, Herbert
Schear, E. W. E.
Shetrone, H. C.
Spencer, Warren P.
Steidtmann, W. E.
Taft, C. E.
Van Cleef, Eugene
Wells, John W.
Yowell, E. I.

---

*One of the three names presented by the nominating committee for membership on this committee does not appear in the membership list of the Academy, hence only two members serving until 1946 can be included at present.

†The Vice-President-elect of Section G found it impossible to accept the office, hence the membership committeeman has been advanced to the vice-presidency, leaving his post to be filled.

REPORT OF THE FIFTY-THIRD ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The Council thought seriously this year of suspending the annual meeting because of the war, but finally decided that organizations of lesser geographic extent could fill an even more important place while national groups are so generally abandoning their meetings. The annual meeting was therefore planned to take place on the campus of the Ohio State University on the last two days of April and the first of May, 1943.

The session opened with a meeting of the Executive Committee at 2:30 P. M., April 29, followed by the annual meeting of the Council.

In place of the Thursday evening lecture presented in recent years, the Academy accepted the invitation of the local chapter of the Society of the Sigma Xi to attend a lecture by Professor Peter Debye of Cornell University on "The Magnetic Approach to the Absolute Zero of Temperature," and the invitation of the Columbus Audubon Society to hear Dr. Donald J. Borror of the Ohio State University in a lecture on "How to Identify Birds."

The sectional meetings occupied Friday. The Mathematics Section presented no program, since mathematicians of the region had already shared in a meeting earlier in April, and the Physics Section did not meet independently because of the opportunity to participate in the program of the American Physical Society. The Junior Academy presented its usual excellent program on the following day. With these exceptions Friday's programs surpassed the Council's expectations and provided ample proof of the worth of state meetings under existing conditions. The printed program shows a total of 95 papers varying in length from ten minutes to an hour, and three symposia, one a general meeting on conservation and two in the sections of geography and chemistry on the special problems of wartime teaching.

In addition to this portion of the program, the Ohio State Museum presented a number of interesting special exhibits.

The banquet was served in the Faculty Club to approximately one hundred members. Dr. Roderick Peattie, as toastmaster, presided genially, presenting first, President Howard L. Bevis of the Ohio State University in a brief greeting. In a week flooded with such occasions, President Bevis graciously divided his evening between the Physical Society and the Academy. Dr. Clarence Ward of Oberlin College responded for the Academy in the cultured and scholarly manner that his friends know always to expect from him.

Following the excellent dinner President Krecker delivered his retiring address on "Woods and Trees," emphasizing brilliantly the broader opportunities of his field, biology, and painting an optimistic picture of the future of man.

In the annual business meeting the one amendment to the constitution was adopted, creating a new class of Honorary Life Members, and three members were elected to the new rank under suspension of the time limit cited in the amendment. These members are:

ALEXANDER, WILLIAM H.
MOSELEY, E. L.
OSBORN, HERBERT.

Dr. S. R. Williams read a brief statement in place of the finished report of the Committee on Necrology to be supplied later for publication.

The report from the Council, read by the Secretary, included a list of thirty-three new members and thirteen fellows. Those elected to fellowship are:

BILLS, ARTHUR G.
CASTER, KENNETH E.
COLE, L. E.
COOPER, JOHN R.
DEXTER, RALPH W.
HENDRICKSON, GORDON
MATHEWS, C. O.
MILLER, JOSEPH N.
RIEVESCHL, GEORGE, JR.
SCOFIELD, HERBERT T.
STECKLE, LYNDE C.
VAUGHN, JAMES
WARNER, EDWARD N.

Dr. Ira Wilson presented the report of the Committee on Resolutions, expressing the Academy's appreciation to our hosts for a very successful, pleasant and ably managed meeting.

Respectfully submitted,

A. W. LINDSEY, *Secretary.*

REPORT OF THE TREASURER

Columbus, Ohio, May 3, 1943.

To the Ohio Academy of Science:

I submit herewith a financial statement of the condition of the Ohio Academy of Science as of December 31, 1942. The books have been audited and the opinion of the auditor is herewith attached.

Respectfully submitted,

Clarence E. Taft, *Treasurer.*

EXHIBIT A

Ohio Academy of Science Balance Sheet as at December 31, 1942

Assets		
CURRENT EXPENSE FUND:		
Cash on Hand		$ 20 00
Cash in Bank		1,008 67
Total Cash		$1,028.67
DUES RECEIVABLE:		
1939	$ 25 00	
1940	95 00	
1941	217 50	
1942	412 50	
Total Dues Receivable		750 00
Interest Receivable		19.50
Bonds—Consolidated Federal Farm Loan		1,300 00
Total Assets—Current Expense Fund		$3,098.17
RESEARCH FUND:		
Cash in Bank	$ 284 78	
Capital Stock—Banc-Ohio Securities Company (cost)	437 50	
Bonds—Fort Hayes Hotel, Columbus, Ohio (cost)	1,300 00	
Total Assets—Research Fund		2,022.28
TOTAL ASSETS		$5,120 45
LIABILITIES, DEFERRED CREDITS AND NET WORTH		
LIABILITIES:		
Accounts Payable (Subscriptions Journal of Science)		$ 750.00
DEFERRED CREDITS TO INCOME:		
Reserve for Uncollected Dues Receivable	$ 750 00	
1943 Dues Collected in 1942	20 00	
Total Deferred Credits to Income		770.00
Total Liabilities and Deferred Credits to Income		$1,520.00
NET WORTH:		
Ohio Academy of Science:		
Current Expense Fund—Surplus	$1,478.17	
Reserve for Investment	100.00	
Total Net Worth—Current Expense Fund	$1,578.17	
Research Fund—Surplus	2,022.28	
Total Net Worth (Schedule 1)		3,600.45
TOTAL LIABILITIES, DEFERRED CREDITS AND NET WORTH		$5,120.45

EXHIBIT B

Ohio Academy of Science Statement of Income and Expense

Current Expense Fund

For the year ending December 31, 1942

Income:			
Dues for the year 1942			$1,287.00
Grants for Research			157 50
Sale of Publications			38 09
Gift for Investment			100 00
Interest on Bonds			39 00
Total Income			$1,621 59
Operating Expenses:			
Clerical Assistance		$ 25 00	
Postage and Telegraph		110 46	
Office Supplies and Expenses		83	
Expenses—Officers to Meetings		24 59	
Expenses—Speakers		25 00	
Printing:			
Proceedings of Ohio Journal of Science	$233 24		
Other	126 92		
		360 16	
Research Grants		157 50	
Subscriptions to Ohio Journal of Science		750 00	
Secretary's Honorarium		100 00	
Safety Deposit Box Rent		3 60	
Bond for Treasurer		5 00	
Auditing Expense		15 00	
Bank Charges		6 96	
Total Operating Expenses			1,584.10
Net Operating Income			$ 37 49
Other Income:			
Dues Collected for Prior Years:			
1939		$ 17 50	
1940		62.50	
1941		122 50	
Total Dues Prior Years			202 50
NET INCOME FOR THE YEAR			$ 239 99

EXHIBIT C

OHIO ACADEMY OF SCIENCE STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS (CURRENT EXPENSE FUND)

For the year ending December 31, 1942

CASH BALANCE—December 31, 1941		$ 262 43
DEPOSITS FOR THE YEAR:		
Dues 1939	$ 17.50	
Dues 1940	62.50	
Dues 1941	122.50	
Dues 1942	1,258.00	
Dues 1943	20.00	
Research Grants	157 50	
Federal Farm Loan Interest Coupons	58 50	
Sale of Publications	38 09	
Gifts and Grants for Investment	100 00	
Total Deposits, 1942		1,834 59
Total Cash to be Accounted for		$2,097 02
DISBURSEMENTS (Checks Written):		
Accounts Payable	$234 25	
Clerical Assistance	25.00	
Postage	110.46	
Office Expense and Supplies	.83	
Expense of Officers to Meetings	24 59	
Printing	360 16	
Research Grants	157 50	
Secretary's Honorarium	100 00	
Speakers Honorarium	25 00	
Safety Deposit Box	3.60	
Bond for Treasurer	5.00	
Auditing Expense	15 00	
Bank Charges	6.96	
Total Disbursements		1,068.35
CASH BALANCE—December 31, 1942		$1,028.67
Cash on Hand—December 31, 1942		$ 20.00
Cash in Bank—December 31, 1942		1,008.67
TOTAL CASH		$1,028.67

AUDITOR'S CERTIFICATE

COLUMBUS, OHIO, May 1, 1943.

The Ohio Academy of Science,
Columbus, Ohio.

GENTLEMEN:

In accordance with your instructions, I have audited the accounts and records of the Treasurer of the Ohio Academy of Science for the year ended December 31, 1942.

I did not audit the accounts shown in the Research Fund. They are presented as submitted by Dr. Herbert Osborn to the Treasurer of the Ohio Academy of Science.

Subject to the foregoing qualification and based upon such examination, in my opinion the accompanying Balance Sheet, Statement of Income and Expense, and supporting statements and schedules fairly present the financial position of the Ohio Academy of Science at December 31, 1942, and the results of operations for the year ended on that date.

Respectfully yours,

DANIEL M. SHONTING,
Certified Public Accountant.

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

The Research Fund of the Academy had a balance of $210.53 in the checking account at the beginning of the year 1942 and as no grants were made from this fund and additions amounted to $74.25, the balance on deposit at the Ohio National Bank was $284.78.

SUMMARY OF RECEIPTS AND ASSETS

Balance in Bank as of December 31, 1941	$ 210.53
Receipts from Interest, etc.	74.25
Total	$ 284 78
Disbursements	0 00
Balance in Checking Account December 31, 1942.	$ 284 78

ASSETS

Bonds (at cost)	$1,300 00
BancOhio Stock (at cost)	437.50
Cash on Deposit, Ohio National Bank	284 78
Total	$2,022 28

The grant of $152.00 from the A. A. A. S. for 1942 was by approval of the trustees allotted to Drs. Wolfe, Scofield and Wareham for continuation of their microclimatic studies in Hocking County and a similar grant from the A. A. A. S. for 1943 of $172.00 has been allotted by our approval, $100.00 to Drs Wolfe, Scofield and Wareham for further continuation of their project in Hocking County, and $72.00 to Dr. Carl Venard for studies of the mosquito populations in Ohio.

It should be noted that the allowances from the A. A. A. S. are expected to be allotted and spent within the year and as these allotments are made on approval of the Trustees of the Research Fund, applications are desired in advance for the anticipated allowance for 1944.

The addition of $36.50 to the balance of last December from later receipts gives us a balance of $321.28 on deposit and unless there are requests for grants for worthy projects from the Academy fund it would seem desirable to invest a part of this balance and we would suggest purchase of U. S. War Bonds if approved by the Academy.

Respectfully submitted,

HERBERT OSBORN, *Chairman*,
PAUL B. SEARS,
F. C BLAKE.

Trustees

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The Executive Committee held two meetings during the year, one on November 21, 1942, and one on April 30, 1943, just preceding the annual meeting of the Council, whose first meeting took place on January 16. Since actions of the Executive Committee other than minor routine details are presented to the Council for action, the following report may embrace the significant transactions of both groups.

The discussion of the desirability of an annual meeting of the Academy was brought to an affirmative end that seems to have been amply justified. We may anticipate the continuation of these meetings during the war.

During the year the Academy received a bequest of $100.00 from the estate of Hermine Z. Hansen. The Council approved the addition of $12.50 to this sum, $11.00 of which was used, the total to be invested in Victory Bonds of $150.00 face value.

At the first meeting of the Council a suggestion from the Botany Section that its name be changed to the Plant Science Section was approved. The Section voted this change at its annual meeting.

A proposal from President Krecker to extend the interest of the Academy in Conservation to the human species was discussed in both meetings of the Council, culminating in the approval of a committee to work on the subject during a period of five years. For this period the committee is to consist of Dr.L . H. Snyder as chairman, Dr. R. A. Hefner, Dr. W. P. Spencer, and two other members, one a physician, to be appointed by the president. This committee is to be a pioneer organization in surveying the possible field of activity, and is to report to the Council at its next annual meeting. At the end of the five-year period it is hoped that the committee may suggest plans for its own future.

The Council also considered the problem of investment of permanent funds and asked the Treasurer, aided by one other member, to study the subject in the interest of security and satisfactory yield for the benefit of our membership.

An important attainment of the year is the settlement of the long-standing discrepancy in the publication accounts of the Academy and the Ohio Journal of Science and in the establishment of definite regulations for the future. These regulations provide that members in arrears at the time of the annual meeting, or on May 1 if no meeting is held, shall be dropped from the mailing list of the Journal until arrears are paid.

The Council voted unanimously to carry with deferred memberships all members of the armed services of the United States for the duration of the war. Dues will not be charged during this period and the members concerned may resume their active membership when they return to civilian life by paying the dues current at that time.

The Council calls attention of all members to the prosperous condition of our research fund, with a balance of over $300.00 subject to application in addition to approximately $150.00 available annually from the A. A. A. S. Applications for grants should be addressed to Dr. Herbert Osborn, Chairman of the Trustees of the Research Fund, who may be reached during the summer and early autumn at the Ohio State University.

The Council also adopted a provision that sections failing to participate in three successive meetings of the Academy shall be dropped, since such a failure may be taken to indicate that the members feel no need for the organization.

Respectfully submitted,

A. W. LINDSEY, *Secretary*.

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

COLUMBUS, OHIO, April 3, 1943.

To the Ohio Academy of Science:

The annual meeting of the Joint Administrative Board of the Ohio Journal of Science was held at the Ohio State University April 3, 1943. Present were Drs. Snyder and White, representing the Ohio State University; Drs. Spencer and Ray, representing the Academy; and Drs Blaydes and Miller, representing the Journal. In the absence of the Chairman, Dr. Patrick, Dr. Spencer nominated Dr. Snyder to act as Chairman; seconded by Dr. Ray. The motion carried.

Dr. Snyder called the meeting to order at 11:00 A. M. The minutes of the preceding meeting were read and approved.

The editor's report, given by Dr. Blaydes, included an analysis and summary of the manuscripts on hand. Thirty-three papers have been accepted and are available for publication. In addition manuscripts of special interest are being solicited with plans to include them in forthcoming issues.

The following motion was presented by Dr. Ray and seconded by Dr. Snyder:

> Upon the receipt of an acceptable paper from an Ohioan, who is not a member of the Academy, the editor shall enclose a membership blank along with the acceptance of the paper.

The motion was carried.

The acceptance of the editor's report was moved by Dr. Ray and seconded by Dr. Spencer. The motion was carried.

The business manager's report was given by Dr. Miller. The financial statement follows:

The Ohio Journal of Science—Fiscal Year 1942

Receipts

Balance from 1942	$ 186.43
University Allowance	750.00
Ohio Academy of Science—pro rata of Dues	611.00
Ohio Academy of Science—Proceedings	233.24
Subscriptions	83.00
Sale of Back Numbers	43.75
Author's Payments for Plates	130.20
Payment by Author of Publication Costs	40.00
	$2,077.62

Expenditures

Spahr and Glenn Co., Printing Vol. 42 and Envelopes and Stationery	$1,530.10
Bucher Engraving Company	286.42
Postmaster	41.19
Bank Charges	3.94
Refund to Franklin Square Agency	68
	$1,862.33
Balance on hand January 28, 1942 (Huntington National Bank)	215.29
	$2,077.62

Drs. Snyder and White were appointed as auditors. Dr Spencer moved the acceptance of the business manager's report; seconded by Dr. White. The motion was carried.

A motion by Dr. Ray; seconded by Dr. White, was that Drs. Snyder, Blaydes, and Miller, be empowered to select an assistant business manager. The motion was carried.

The committee adjourned at 2:00 P. M

Respectfully submitted,

JOHN A. MILLER,
Secretary of the Board.

REPORT OF THE LIBRARY COMMITTEE

COLUMBUS, OHIO, April 27, 1943.

To the Council of the Ohio Academy of Science:

The past year has been so uneventful in library work that it has not even been necessary to bring any matters to the attention of the other members of this committee. Claiming numbers of journals that failed to arrive, posting individual issues of our own journal, keeping the mailing list correct, and making a few sales have been about the extent of the work during the entire year.

The sales of publications amounted to $31.15 including tax. This sum, with an itemized statement, has been given to the Treasurer. One sale was for more than $22.00, as a southern university which owned a few scattered numbers of the Proceedings purchased all the remaining numbers in order that it might have a complete set. Thirteen other sales were made, consisting of sixteen copies of eight different Special Papers. Eight of the fourteen sales were to people in Ohio and one each of these places, Connecticut, New York, Washington, D. C., Louisiana, Michigan, and Wisconsin. The sales have been increasing somewhat each year since the all-time low of $7.65 in 1939.

Last year the members of this committee considered ways to circulate more of the stock of the Academy publications. Two plans were suggested and the results were to be reported this year. One plan was to send the price list to book dealers, as it had been some years since this had been done. Accordingly a new list was mimeographed and copies were posted to thirteen dealers, but with no results so far. The other plan was to make use of the new Union List of Serials which was to appear in the summer of 1942, in order to ascertain the various numbers of the Proceedings which were lacking in the libraries listed in it and offer to supply them on a sale or an exchange basis as the case might be. As the publication of the new Union List was postponed, this plan could not be carried out, but it will be whenever the List is published and its results will be reported to the Council.

Very few foreign exchanges are being received and on our part we are not posting the Ohio

Journal of Science outside our own country except to Canada. New exchanges have been received during the year from Mexico City, San Salvador, and Harvard University.

Respectfully submitted,

ETHEL MELSHEIMER MILLER, *Chairman.*

REPORT OF THE COMMITTEE ON NECROLOGY

To the Ohio Academy of Science:

Our roster of members has been depleted during the closing academy year by the decease of six members; one of whom had been a member about thirty years, one about twenty years, three about ten years, and one only one year. Each is a distinct loss to science and to the Academy. The youngest, Dr. Pierstorff, was born in 1895, Dr. Inman five years earlier. Messrs. Mathewson and Matheny were each about sixty, and Mr. Chase and Miss Nichols seventy.

SUSAN PERCIVAL NICHOLS was born in Maine in 1873, completed her public school and was graduated from Cornell University in 1898. She was a fellow in Botany at Cornell the next year and had an American University Woman's table at Naples Zoological Station. After two years of teaching at Houghton Seminary, New York, she was a fellow at Wisconsin, 1902–03, and was given the Ph.D degree there in 1904. For four years she taught in a private school in Kentucky and then began her life work as instructor in Botany in Oberlin College. She rose through the ranks to a professorship in 1925, and after several years as head of her department, retired in 1938.

Dr. Nichols was modest and retiring, a keen observer, a skillful technician in spite of the physical handicap of a withered arm, an inspiring teacher, a clear thinker and consistent research worker. Although always teaching a full schedule she brought several studies to fruition, presented her results to scientific societies, and published them. These characteristics and performance made a deep impression upon many a student. Her studies at her home in Portland, Maine, on native orchids were interrupted by her death.

Dr. Nichols was for many years an active member of the Ohio Academy (became a Fellow in 1922), of the A. A. A. S., the American Society of Naturalists, and of the Jossylin Botanical Society of Maine.

JOHN H. CHASE was born in Atlanta, Ga., October 25, 1873, where his father was a professor in Atlanta University. He received his B.S. degree from Amherst College and M.S. from Columbia University, after which he became a social worker in New York City. He continued his welfare work in Cleveland and Cambridge, Mass., and about thirty years ago came to Youngstown. He became executive secretary of the Youngstown Playground Association and was through all his work there a pioneer full of good working ideas. He lived to see accepted as necessities many of his "revolutionary ideas."

Better housing, supervised play, better understanding between the Negro and White races, water conservation, tree planting, and various phases of conservation were enthusiastically supported by him. He worked through the schools, Y. M. C. A., Y. W. C. A., Scouts, and Fresh Air camps. He served as president of the Ohio Nature Clubs, and of the Youngstown Nature Study Club and as trustee of the Natural Resources Council.

His zeal and inspiration rose highest when he could interest boys and girls in plants, animals, stars, rocks, minerals, experiments, or play. He was the foremost local authority in Geology and published "Introducing Our Ancestors," "Geology Trails," and many newspaper articles. He had completed a paper on "Earth Rhythms" for the Academy meeting last spring. A few days before the meeting he wrote the chairman of his section, "Because my health is not tops I may not be able to make the trip," and enclosed a copy of his speech. He died in sleep before the day of the meeting.

Youngstown bestowed many honors upon Mr. Chase, not the least being John H. Chase Day in 1935 when 3,000–4,000 persons turned out to do him honor. In his later years he was proud to be chosen professor of Geology in Youngstown College, where he stood strong for field work and actual contact with the things and phenomena of his science.

WILLIAM ALEXANDER MATHENY was born in 1882 here in Ohio. After the regular public school program he entered Ohio University at Athens and received the B.Ph. degree in 1908.

The next year he added the A.M. degree from Clark University and in 1911 his Ph.D. from the same institution. He served as assistant in Botany these three years at Clark. He was invited to teach Botany in his Alma Mater at once and became professor of Civic Biology and Botany at Athens, Ohio, University, in 1912, which position he held until his death of pneumonia January 15, 1943.

He joined the Academy in 1933 and was a member of A. A. A. S. His investigations were in several civic and biologic fields; drink-cup problems, house fly, seed dispersals, and physiologic effects of alcohol.

STANLEY B. MATHEWSON was born in Georgia in 1884. At the age of twenty he was given his B.S. by the Georgia School of Technology, Atlanta. Much of his life work has been in various aspects of personnel and in administrative positions in chemical and industrial institutions. He has served as a District Manager of Bell Telephone and Telegraph Co., as Regiona, Director of the National Labor Relations Board, as a member of the National Research Council and the Vocational Guidance Conference of Economic Security. He was a Major in A. G. Reserves, 1918–39, a member of the American Legion, A. A. A. S., National Audubon Society, and the Florida Audubon Society. He became a member of the Ohio Academy of Science in 1931, Section on Psychology. He was a member of the Episcopalian Church, the Kiwanis and several other clubs. He published several books and papers on Personnel, Labor, Management, and Unemployment Insurance.

Mr. Mathewson had recently retired to Melbourne, Fla. His work brought him in close touch with many men among whom he always moved with ease—welcome in any group.

ONDESS LAMAR INMAN was born in Bloomfield, Ind., November 11, 1890, was given an A.B. by Indiana University, 1915, B S. by University of Idaho, 1918, and Ph.D. by Harvardl 1921. He held a teaching fellowship and instructorship in Botany at Idaho, 1915–18, and Austin Teaching fellowship at Harvard, 1919–20. Dr. Inman became professor of Biology at Antioch College in 1921, shortly changed to Physiology, and became Dean in 1929, which positions he filled until 1930 when he became Director of the C. F. Kettering Foundation. His main work here was experimental research on chlorophyl. He was a member of A. A. A. S. and Botanical Society of America and joined the Academy in 1923, serving as vice-president in 1935.

Some of his special interests were Respiration injury and recovery processes; Symphalangism; pathogenic bioluminescent bacteria; metabolic studies on *Chlorella clathrata;* chlorophyl and photosynthesis. He prepared a key to the Genus *Calamagrostis.*

While much of his work was done as a member of Antioch College faculty he always wanted time for research and welcomed the call to devote all his time to study and experiment.

ARTHUR LEWIS PIERSTORFF was born November 12, 1895, and died July 28, 1942. Dr. Pierstorff was graduated from the Ohio State University in 1919 with a degree of Bachelor of Arts, and received the degree of Doctor of Philosophy from Cornell University in 1929. He was a second lieutenant, field artillery, U. S. Army, in 1918.

Dr. Pierstorff was assistant county agent at Rochester and Fredonia, New York, 1921–22; research fellow at Cornell University, 1922–23; plant disease director of the New York State spray service at Cornell University, 1924–26; extension horticulturist at Rutgers University, New Jersey State College of Agriculture, 1926–27; extension plant pathologist and associate professor of botany at the Ohio State University, 1928–38, and associate professor of botany in the same institution from 1938 to the time of his death.

Dr. Pierstorff was a recognized authority in the field of plant pathology and pology. He organized a centralized scab spray service for the state of Ohio, which has been an outstanding service to the orchardists of the state. The effects of his very capable and efficient service in extension work will long continue to be evident in all parts of the state.

Dr. Pierstorff's affable, sincere, and genuine manner, and his warm personality won him many friends among his colleagues and among the agriculturalists of the state.

Our losses always sadden us yet we find satisfaction in contemplating these lives of accomplishment.

Respectfully submitted,

GEO. D. HUBBARD.

WOODS AND TREES[1]

FREDERICK H. KRECKER
Ohio University, Athens, Ohio

Some of you, I am sure, are wondering why a zoologist should presume to discuss a subject which apparently lies within the domain of the botanist. Of course to be strictly zoological I might have used the words formicaries and ants, but no one before me has said, "One can't see the formicary for the ants," and I do not presume to establish a saying.

I have had considerable experience instructing the general arts college student, the student who takes zoology as a college requirement and without thought of continuing in the field beyond the limits of the course. Each year at about this season, after all the tumult and the shouting of instruction have died down, in the wee small hours of the fading academic year, I take stock and ask myself in troubled seriousness, "What have I conveyed to my charges?" Facts, most certainly; but facts without their significance are as food without vitamins. One is filled but does not thrive. Hence, I query, have I been content to show to my students merely the trees of fact, each after each in all their intricacy of detail, or have I also taken them to a vantage point and shown them the beauty and majesty of the forest? Have I, in other words, taken full advantage of the opportunities which President Brown of Denison at our last meeting so eloquently ascribed to the instructors of science. You will remember that in the course of his remarks he humorously itemized the tongue twisting terms that met his gaze as he reviewed the requisitions of his scientific staff. President Brown, however, saw beyond the terms and the facts they represent. He saw them as a means not as ends. Unfortunately some members of our scientific fraternity, not to mention the man in the street, see only the terms. Nothing is so revealing, so pathetically revealing, as the desperate efforts the casual acquaintance makes to find a common ground of conversation once he discovers you are a zoologist. All too often he amusingly, likewise tragically, attempts to recall a name—oh, yes, he says, I studied zoology once. Let me see, what is the name for oysters and clams? . . . That man has seen the trees. I wonder whether he was ever shown the woods; whether he was trained in anything but bare facts. And I wonder too whether, perhaps still more unfortunately, the significance of significances was ever appreciated by his instructors.

The trees and not the woods loomed large in the remarks made by a colleague of mine, a purveyor of the humanities, on the occasion of a round table discussion between a faculty group and students on the ever-recurring topic of science and religion. The immediate question at issue was the relation of scientific facts to religion. My colleague was of the opinion that the two could be in no wise related. By way of illustration he pointed to the facts of meteorology; certain conditions of temperature, moisture, atmospheric movement we know result in rain. How can that knowledge possibly have any connection with religion, he queried. The answer, as we well know, is simple. This certainty of results which the meteorological facts represent takes much of the mystery and consequent uncertainty out of the comings and goings of the weather. To just that extent we feel secure and in harmony with the powers that ride the storm.

My colleague's query did double duty. It revealed the barren trees of both science and religion but the woods of neither. The fundamental yearning which the appeal to religion strives to fulfill is the yearning for security, a yearning which grips all of us. We tremble before the overpowering uncertainties of enveloping fate, the unknowable, and strive to achieve a harmonious relationship through religious experience. The woods, which apparently neither the scientific nor the religious experiences of my colleague had revealed to him, were that just as the all compelling quest manifested through religion is the quest for security so the all embracing fruit of science is to afford security; the security that frees from the bonds of uncertainty and superstition and soothes the troubled soul with the peace that passeth understanding.

---

[1] Address of the retiring president of the Ohio Academy of Science delivered at the annual meeting of the Academy held in Columbus, Ohio, April 30, 1943.

This doctrine of security, the teaching that we live in an environment ordered by dependable, understandable principles is as old as science itself, the *leit motif* that has threaded its guiding way through scientific thought throughout the ages from the times of the early Ionian teachers to the present. As F. H. Pike[2] reminds us in a published note within the year, "One great change which occurred in the period from Thales to Plato was the substitution of a world, perhaps even a universe, of law for the older world of caprice." And with it there was born a new thing, "science," which as Burnet[3] so aptly defines in his survey of Greek philosophy is "thinking about the world in the Greek way."

To return to my colleague and, I fear, to many others like him, what a woeful void there must have been in what he reaped from science, perhaps also in the guidance offered him by his mentors. One is moved to paraphrase the biblical interrogation, what doth it profit a man to gather the facts of science and lose its soul?

One group of scientific facts, its bare, gaunt trees stripped of their pleasing foliage, tells us that every particle of matter is attracted by every other particle in proportion to the product of the masses and inversely as the square of the intervening distances. These few words represent a vast number of subsidiary facts and a prodigious amount of painstaking effort in their formulation. It is known to all who mull them over that they explain the floating of a mote of dust to the ground and in the same breath the grand movement of the planets through space. I am wondering, however, how many of those who have burnt the midnight oil in mastering these facts, how many of our students, indeed perhaps, how many of their instructors and how many of our friends in the humanities like my colleague of the religious discussion have been taken to a mountain top from which they have been able to see that these same facts have served also as a guide post in our quest of the ultimate, in moulding man's interpretation of his universe, in orienting himself in time and space; that they have been one of the things which has helped to satisfy man's wonder, the awsome wonder that comes over one as he gazes into the depths of a star-studded winter sky where wonder leads to wonder and one is moved to breathe the thought, "What is man that thou art mindful of him?"

As Sir James Jeans[4] points out, "The law of gravity was important not so much because it told us why an apple fell to the ground or why the earth and planets moved around the sun as because it suggested the whole of Nature was governed by hard and fast laws—in the light of Newton's work—Man began to see that he was free to work out his own destiny without fear of disturbance from interfering gods, spirits, or demons." Or again to partly paraphrase Dampier,[5] Newton's reduction of the phenomenon of gravity to mathematical terms, coupled with the work of Copernicus and Galileo, in one grand sweep validated terrestrial mechanics in celestial spaces and eliminated with finality the Aristotelian and mediaeval doctrine that "the heavenly bodies are divine, incorruptible and different in kind from our imperfect world." The effect was even deeper and struck at the very roots of religious beliefs in that it was made "impossible any longer to gaze into heaven just above the sky, and to shudder at the rumblings of hell beneath the ground." Consequently, as Brett[6] comments, "The seat of religious belief was thus moved from the heart to the head; mysticism was excommunicated by mathematics, . . . the way was opened for a liberal Christianity which might ultimately supersede traditional beliefs."

---

[2] Science, April 24, 1942.

[3] Early Greek Philosophy, 4th Edition, 1930.

[4] "Scientific Progress."

[5] Sir William Dampier, "A History of Science," 1938.

Incidentally a statement like that is indeed comforting to a zoologist. It lifts from his shoulders some of the burden placed there by the populace for having undermined ancestral beliefs.

Biology's central contribution to human thought has been the doctrine of organic evolution. This doctrine has brought coherence and order and significance to a multitude of otherwise apparently disconnected facts and theories within the field of biology itself and has opened up wide vistas of vision in other fields as well. It is undoubtedly superfluous to mention this to a scientific assemblage such as this, but there are scientists, even biologists, who tend to belittle the importance of evolution in the scheme of instruction. And here again I am moved to wonder whether we see the woods as we look at the trees; whether we consider the fact of the evolutionary origin of animals and plants as an end in itself and the meticulous details of evidence as ends in themselves or whether we look upon them as means to a broader end. As ends in themselves they are probably pleasant bedtime stories, if you like that kind of story. They are facts and add to one's store of such things, if your hobby is making a collection. If that is the spirit in which one presents the matter embellished for good measure with much precise detail, I fear that in the words of the philosopher, Irwin Edman, once applied to some of the humanities, it will be shortly "dying of anemia, of archeological hardening of the arteries and will become a corpse handled conscientiously by solemn morticians."

As means to an end the formulation of the doctrine of organic evolution, like the formulation of the principles of gravity, has served as the factual basis for a reorientation of human conceptions. If Newton paved the way for a liberalized Christianity, Darwin has paved the way for a liberalized socio-political outlook. The doctrine of organic evolution has once and for all destroyed the concept of the immutability of human institutions as well as of animal bodies. It has destroyed finality. If man as an animal is the product of change, his institution, the state, as a socio-political organization is not immutable. What served the purposes of our fathers may not of necessity serve ours. And so also have we been conditioned to discard the concept of absolutism in the field of economics. With changing times come changing economic principles.

Organic evolution with its handmaiden, natural selection, has destroyed the sociological equalitarianism of the French revolution. All men may be equal before the law; they are not equal before the bar of life. Gone too is the categorical dictum as a basis for morality and in its place has come racial experience, those standards which have survival value for the race. Morality in this light comes to mean allegiance to that code which will enable one's countrymen to live and to have life more abundantly. For those who may mourn the passing of the categorical standard, let me say that racial survival is a far more exacting standard than one which, perchance, permits of compensation by doing penance. The youthful monkey merrily swinging from limb to limb who misjudges his mark gets no second chance and leaves no descendants. It is, indeed, easier for a camel to pass through the Needle's Eye than to cheat the laws of life.

---

[6] G. S. Brett, "Sir Isaac Newton," 1929.

There is tonight no time, even if this could be considered an appropriate place, in which to trace all the ramifications of our racial experience as a standard by which we may order our lives. However, I should like to enlarge upon one phase of our experience which does appear to be peculiarly applicable to the present state of world affairs. Julian Huxley,[7] in discussing man's achievements points out, as have others, that "the next step of greater control must be over man himself . . . through (among other methods) doing away with nationalistic drives and superimposing an international form of government on the world." To a biologist there straightway comes the question, what evidence have we that cooperation is any more successful than isolation as a biological method? Has not the arch isolationist, Amoeba, survived for millions of years and have not thousands of other rugged individualists been successful among the animal hordes? That interrogation immediately poses another—what is success? And to answer one must differentiate between survival and mastery. An animal, all of us, may survive through a variety of devious subterfuges and expedients, the common mark of which is that they entail subservience. However, success in fullest measure is mastery over conditions. If organic evolution has any significance it is the story of how living material has through the cooperative actions of its subdivided units approached, if it has not yet attained, mastery.

I am fully aware of the fact that organic evolution does not of necessity proceed along a straight line principle, that life has followed a thousand and one devious pathways and on occasion has even retrogressed; but the fact remains, nevertheless, that at each level on which there has been a closer approach to mastery that approach has been accompanied by a greater division of labor and a closer coordination of the constituent units until in man the master, they have become woven into an intricate pattern of cooperating parts. At the opposite extreme lies an ineffectual, single-celled droplet of living material exemplified by Amoeba. Organic evolution is thus history, as much a part of our history as is the history of the written word, and as such, in fulfilling one of its functions, it points out the road we have trod and lights the way that lies ahead.

I am a zoologist, but for a moment I should like to turn historian, that man who has been termed by Schlegel a prophet looking backward, and as such a prophet refresh your memories by briefly tracing the steps of this story as others have done before me.

It can begin with Amoeba, a creature which epitomizes individualism. Not even in the commonly shared function of reproduction is it dependent upon another for assistance. A thousand and one changes have been rung on this isolationist-individualist theme among its fellow protozoans, each change having brought survival but no shred of mastery.

One of the early mutations leading out of the protozoan doldrums was that which resulted in causing proliferating cells to remain clustered together, and as such clusters to cooperate in the form of tubular units; a condition exemplified in varying degrees by the Porifera and the Coelenterata. The rewards were those that come from numbers and elementary divisions of function. This condition was followed by an innovation which resulted in dense, compact and solid masses of cells being able to exist as a single unit exemplified by our friends and tormentors, the flatworms. This state of affairs was accompanied by greater diversification in the constituent units and preeminently by rectilinear locomotion.

The next steps—three of them—in this mutating series were particularly significant; the development of distance receptors, the device which produced essentially compound animals, and the accompanying delegation of authority to subcenters which thus made possible the rapid and efficient control so characteristic of the metameric groups.

---

[7] "Man Stands Alone," 1940.

Metamerism is as far as life has gone in the way of physically compounding units. The compounding has continued but on the psychological level, or social level if you wish. If we are to consider psychological reactions as a specialized manifestation of physiological states, the continued compounding which we term our social organization is fully as much a physiological process as were the physical unions just outlined and as such must be considered a direct continuation of this compounding tendency, a continuation made possible by the development of distance receptors.

In saying this, I am mindful of those who maintain that social organization is not comparable to corporate organization. I am inclined to think the difference is not so much a matter of principle as of means. In the one case the constituent units have been held together by bonds of physical contact, in the other they have been as firmly held by the influence of distance receptors. Emerson,[8] the ecologist, has recently expressed the view that, "Regardless of how one interprets the unity of the more complex human societies, the human family, and other family systems, are real cooperative, supra-organismic entities. . . . Society is merely a manifestation of fundamental life attributes which are shared with other biological systems (e.g., multicellular organisms) and the division between the social and the non-social is not sharp." Jennings[9] goes further and points out that there is much to be said in favor of the conclusion that "mankind is a single great organism temporarily divided into pieces—the individuals." Through this device the essential benefits of physical union are retained and become enriched by the advantages to be derived from mobile units. The study of organic evolution is, indeed, from one standpoint essentially a study in populations. Much can be said in support of the conclusion emerging from such a study, that in its animal phases at least unitary masses of protoplasm, whether these units be cells or bodies, under similar conditions follow essentially similar principles of group organization.

The social organization of the corporate population has, as you know, followed along two lines, the one illustrated by certain insects, the other by man. Among insects the culmination is reached by the ants and the termites, those individually defenseless creatures and toothsome morsels for many a foe which have through cooperation lived from the tropics to the borders of the Arctic.

Our own social structure is an even more intricate and widespread culmination of increasingly interdependent component units the progress of which has followed one unswerving path marked by the milestones of free cells, tissues, organs, organ systems, compound organisms, then families, tribes, kingdoms, empires, major alliances, and still it holds its course into the future. Faintly outlined as yet but apparently on our course lies some type of world union. This last prophecy may be branded an ultra-utopian fancy, but it must not be thought that the pyramiding of units I have just traced whether in the field of physical union or socio-political associations came without a struggle, without false starts that led up blind alleys or, indeed, ended in stark failure.

For those who may be faint-hearted, the fact to be kept in mind is that with all the difficulties that beset the way, union was eventually accomplished, that with each union, with each sacrifice of self, with each restriction of liberty, there has been a stride toward greater mastery, toward a fuller, more abundant life for the whole. At one extreme is individualism, represented by Amoeba, beholden by neither jot nor tittle to anyone, grovelling withal in the slime and swept hither and yon by every whim of nature. At the other extreme are millions of interdependent cells united in the form of men who, in turn, through their combined efforts have overcome the sufferings of famine, the scourge of pestilence, the barriers of distance, the mysteries of the air, yes, even the intricacies of creative synthesis. Optimism for the future is well expressed in the words of the palaeontologist, Lull,[10] who writes, "The great heart of nature beats, its throbbing stimulates the pulse of life, and not until that heart is stilled forever will the rhythmic tide of progress cease to flow."

---

[8] A. E. Emerson, Denison University Bulletin, December, 1941.

[9] Journal of Social Philosophy, January, 1937.

Among the social insects the price paid to the group for the benefits of cooperative action is that the individual be born to a class and have stamped upon him unalterably the form of his station in life—worker, soldier, king or queen—there to remain toiling dutifully without will or choice that the group may survive. That is straight-jacketed, inflexible efficiency, not inviting to those of us outside the pale of Nazi or Fascist rule. It has, moreover, fallen short of control, probably because its morphological inflexibility is paralleled by inflexibility of nervous reaction.

There is no gainsaying that one of the most patent of biological principles requires that when individual and species conflict, it is the individual that must give way even to the extreme of life itself. For us the demands of society are indeed becoming more and more exacting; we are individually being held to a closer and closer accounting. There is ever-increasing regimentation. But we of the vertebrate line are fortunate in that we belong to a type of social organization which permits its members the opportunity of realizing their responsibility to the group and of doing their duty voluntarily and without compulsion. If we but will, therein lies our avenue of escape from the fate of an enforced regimentation analogous to that of the insects.

The responsibility which rests upon us individually arises from the division of labor inherent in society. Each sequence in the evolutionary progress of living material from microscopic unit to dominating mass involved more and more detailed division of labor and with each advance there came increasing responsibility. For instance, in an unspecialized body like that of a sponge the entire body, as you well know, can be taken apart cell by cell and then the whole mass or any portion of it can again take on the form and function of a sponge. Here, it matters little whether any one or a group of cells fail At the opposite extreme in man, the loss of an islet of cells in the pancreas means death. Clearly specialization and responsibility go hand in hand.

The inexorable demands of nature that each do his duty to his kind need not of necessity mean that before us lies a future in which we shall be slaves to the State, Nazi-fashion. A slave performs his duty without choice, has no voice in his fate. Before us lies the opportunity to both exercise our choice and discharge our duty. If, however, we do not so choose, we shall have responsibility and no freedom, no chance to direct our fate. There are even now those among us who would impose the prototype of insect rigidity upon our form of social organization. Its most extreme exponents are the followers of Nazi philosophy. Rauschning[11] reports Hitler as declaring, "There will be a master class . . . also a new middle class . . . and the great mass of the eternally disfranchized. Beneath them still will be . . . the modern slave class. . . . Universal education is the most corroding and disintegrating poison that liberalism has ever invented for its own destruction." Carrel[12] has expressed somewhat similar views as for instance, . . . "The democratic principle has contributed to the collapse of civilization in opposing the development of an elite. . . . modern civilization is incapable of producing people endowed with imagination, intelligence and courage. . . . the equality of their (man's) rights is unequal."

It is true that there are biological differences among us which cause difficulties in a democratic state, but gene distribution is such that few are wholly of inferior quality and few, if any, of wholly superior stuff. The mechanism of transmission and interaction of genes further complicates the picture. And who is to differentiate what is good or how? As Jennings suggests, "One of the greatest difficulties in the way of effective human action lies in the lack of agreement as to the end to be attained. . . . perhaps the greatest difficulty of all lies in the lack of agreement as to the individuals or groups that should benefit by the action to be taken."

---

[10] R. S. Lull, "Organic Evolution," 1929.

[11] "The Voice of Destruction."

[12] "Man, the Unknown."

The course upon which the physically undifferentiated and mobile fabric of the vertebrate social organization is set does not of necessity demand a society straight-laced and closely regimented in which freedom of action is surrendered. It does demand and will exact the surrender of action for self alone. It does place upon us unalterably responsibility to our fellow men. The failure on the part of many of us, most of us I fear, to realize this fact has been an important source of our present unrest. With a sense of allegiance to the group in the spirit of that larger self-interest which realizes that the greatest good for the individual is inextricably bound up with the good of the group, there need be no fear of enforced regimentation. Unlike the straight-jacketed insect civilization, such realization of individual responsibility permits us freedom to pass from stratum to stratum as the cast of the genes may decide and leaves us the stimulus of individual initiative. The specializations of society without a sense of responsibility lead to the limited privilege of an unbridled, cancerous growth; specialization with a sense of the common good leads to the harmony of a well-ordered body.

As I come to the end of my remarks let me mention once again my thoughts at the close of the academic year, my interest in the trees of fact and the woods of significance. I have, as you see, directed your attention to but a few examples. First among them was the very soul of science, the sense of security which scientific facts convey. Second was the influence of what may appear to be purely physical principles upon the liberation of man from the bonds of religious ignorance; third, the significance of the facts of evolution as a guiding light upon our way and finally the significance of the individual's obligation to the group. I have discussed them because with all the immediately practical applications of fact that can be made, which are truly many and important, such applications alone are not sufficient. The instructor in science has not completely fulfilled his responsibility to those who come to him for guidance unless he has pointed out the wider significances. These broader applications which carry us into the realm of ideas are required to fully satisfy that age-long quest which Sir William Dampier has so richly clothed in these words:

"At first men try with magic charm
To fertilize the earth,
To keep their flocks and herds from harm
And bring new young to birth.

Then to capricious gods they turn
To save from fire or flood;
Their smoking sacrifices burn
On altars red with blood.

Next bold philosopher and sage
A settled plan decree,
And prove by thought or sacred page
What Nature ought to be.

But Nature smiles—a Sphinx-like smile—
Watching their little day
She waits in patience for a while—
Their plans dissolve away.

Then come those humbler men of heart
With no completed scheme,
Content to play a modest part,
To test, observe, and dream.

Till out of chaos come in sight
Clear fragments of a Whole;
Man, learning Nature's ways aright,
Obeying, can control."

THE ANTS OF THE KILDEER PLAIN AREA OF OHIO

(HYMENOPTERA, FORMICIDAE)[1]

MARY ELIZABETH AMSTUTZ,
203 Samaritan Ave., Ashland, Ohio

This paper consists of a description of the Kildeer Plain, a list of the varieties of ants found, and some notes in regard to their habits of nesting as observed in this area.

Wherever variations in the geological conditions of a region occur, there are found corresponding differences both in the flora and fauna. The climatic conditions including temperature, precipitation, etc., may be quite similar, yet there appear an amazing number of different habitats for living organisms. The very fact that one type of soil is composed of clay while another is composed chiefly of sand or the fact that here may be good drainage while at some distant point may be none at all, certainly determines in no small measure the type of organism which will exist or fail to find desirable environment.

This is true on a large scale across the entire width of the continent, on a smaller scale in the separate states and still more minutely, within the counties themselves.

The species of ants found in the Kildeer Plain Area of Ohio are of particular interest to the myrmecologist, for here is a small area which geologically is unusual in the state.

The following list embracing twenty-seven species, subspecies and varieties is undoubtedly incomplete. Ants have been taken from as many varied habitats as a small plain area presents. They have been taken in a dense oak-hickory forest at the edge of the prairie, on sloping banks of the Tymochtee Creek, along roadsides, in open prairie fields, many of which have not been under cultivation for five or six decades, and open fields that are again being put under cultivation. In the last mentioned instance, the newly plowed furrows were carefully examined for species which otherwise might have been overlooked.

The collections were made chiefly during the summer months of 1938 and the spring of 1939.

Due to the fact that there is no extreme environmental difference within this area, comparatively few species are found, but some of these appear in great abundance, for example: *Formica cinerea neocinerea*, which is known as a prairie ant. Some species living here are not very common elsewhere in the state, and some species commonly found elsewhere are prevented from living in this area abundantly because of the limiting characteristics of the region.

DESCRIPTION OF LOCALITY

The Kildeer Plain area is located mostly in the south central portion of Wyandot County between Tymochtee Creek on the west and the village of Harpster. It extends also into a small section of northwestern Marion County. The area is approximately nine miles in length (east and west) and six miles in width (north and south). Its entire western and most of its southern boundary is determined chiefly by Tymochtee Creek.

---

[1] The writer expresses sincere appreciation to Dr. C. H. Kennedy, under whose guidance and stimulation the work has been done, and to Dr. Mary Talbot who has given so freely of her time, particularly in the checking of identifications. Gratitude is extended also to Dr. Earl L. Core for identifications of the flora of the region and to Dr. J. Ernest Carman who has given valuable assistance in the comprehension of the geology of this plain area.

This plain is one of several found in the state. It is high in comparison with the altitudes of Ohio, its average elevation being almost nine hundred feet, with a general slope toward the north. It is situated in the Ohio-Erie Divide or the Wabash Terminal Moraine Region, and, being in the midst of this great water shed of the state and slightly on the northern slope, there are no large streams. The chief drainage, of which there is little, is the Tymochtee Creek and its tributaries. Just a little farther to the north are the headwaters of the Sandusky River. The general course of both of these streams is due north, toward Lake Erie.

The soils of this area are composed chiefly of three types: Miami silt, Clyde loam and clay loam. H. W. Olson, in studying the soils of this county as a habitat for earthworms, finds the organic content of the soil to vary from 3.5 per cent to 5 per cent, which is considered a high content. The pH of the soils ranges from 7.40 to 8.40, and the moisture content is found to vary, during normal conditions, from 15 per cent to 32 per cent. One conclusion can be drawn immediately from these observations, i. e., that variations in the flora and fauna are not restricted by the lack of organic material in the soil. It is also to be noted that there is considerable change in the moisture content from time to time.

Since the soil in this restricted area is chiefly of a fine texture, it is generally present in one or the other of two extreme conditions: either too wet or too dry. These conditions are not conducive to the healthy growth of flora, particularly of trees. Miss Thompson[2] states, "The affinities of the flora of any region are the product of past geologic and climatic history and of present edaphic and climatic conditions." Fauna, and particularly the type in which we are here interested, is certainly restricted by the lack of certain plants and again encouraged by the presence of others which may be found on the prairie.

The climate for this small area is apparently no great limiting factor in determining the presence of the ants found here, because the climate is consistent with that throughout the state. The mean annual temperature for Ohio ranges from 49° F. in the north to 53.5° F. in the south. Rainfall is abundant over all the state, increasing only slightly in the north.

The ant population of this section is determined both directly and indirectly by past geologic conditions: directly, by the type of soil itself, and the poor drainage; indirectly, by the growth of flora and fauna which is here due to these conditions.

Prairies are chiefly of two distinct types: high and low. The low prairie has been formed from a depression in the moraine region. At various times of the year it is covered with water. The high prairie was formed from depressions or small lakes which have been filled in. It is moist, but above water.

It is generally accepted that the Kildeer Plain is one of the latter type. With the slope of the plain slightly to the north and the recession of the terminal moraine, there apparently was not enough drainage to carry away all the moisture. As the moraine receded farther, the moisture was allowed to drain off and the shallow lake bottom became filled by the slow accumulation of vegetable matter, and perhaps by the washing in of adjacent land and fine soil.

The flora of this plain area will be discussed briefly for two reasons: (1) because it has a direct bearing upon the fauna, and (2) because it, too, is of a different nature than that found over most of the state.

As far back as 1835 the peculiarities of the plant and animal life were noted by Cyrus P. Bradly in his journey from Marion to Sandusky, for he writes, "I shall never forget my ride across the gloomy, unhealthy prairies which produce nothing but long grass, horned cattle, disease, mosquitoes and rattlesnakes. One species of meadow grass was shown to me which is given the singular cognomen of Roman Catholic Grass." (*Hierochloë odorata* (L.) Beauv.).[3]

---

[2] Thompson, Isabel. 1939. Geographical Affinities of the Flora of Ohio. The American Midland Naturalist. Vol. 21, No. 3, May, page 730.

There is much evidence to prove that in earlier times prairies were more numerous and continuous than they now are. This gave opportunity for prairie species to spread, and it seems quite probable that some of the plants found on this prairie now have spread in from the west. Some of the species of plant life here are found only on isolated prairie patches such as are represented by the Kildeer Plain.

The oak-hickory forest on the edge of the plain is typical except that the area is extremely humid. Parts of the forest floor are entirely covered by jewel weed (*Impatiens biflora* Walt.)[4] At the edge of the forest the following plants are in evidence: water plantain (*Alisma plantago-aquatica* L.), button-bush (*Cephalanthus occidentalis* L.), wild yellow lily (*Lillium canadense* L.) and sensitive-fern (*Onoclea sensibilis* L.).

Scattered here and there throughout the plain area is the cotton wood tree (*Populus deltoides* Marsh). This tree is found typically, bordering streams and moist places, and here too, it finds favorable conditions for growth.

A few of the remaining typical plants in the Kildeer Plain are:

Hairy Milkweed	(*Asclepias pulchra* Ehrh.)
Sulivant's Milkweed	(*Asclepias sulivantii* Engelm.)
Sallow Sedge	(*Carex lurida* Wahl.)
Spear Thistle	(*Cirsium lanceolatum* (L.) Hill)
Squirrel-tail Barley	(*Hordeum jubatum* L.)
Slender Rush	(*Juncus tenuis* Willd.)
Wing-angled Loosestrife	(*Lythrum alatum* Pursh.)
Flat-stemmed Blue Grass	(*Poa compressa* L.)
Virginia Rose	(*Rosa virginiana* Mill.)
Dark green Bulrush	(*Scirpus atrovirens* Muhl.)
Fringed Yellow Loosestrife	(*Steironema ciliatum* (L.) Raf.)
Western Ironweed	(*Vernonia fasciculata* Michx.)

Western Ironweed is recorded for Ohio only in two counties: Erie, which borders Lake Erie, and Wyandot, the county in which Kildeer Plain is located. Sulivant's Milkweed is an illustration of plant life which occurs in isolated prairie patches.

All of the plants here recorded are typical of one of the following situations, each of which is closely allied to the other: roadside, meadow, moist meadow, prairie, swamp margin, swamp and wet woods. Such are the conditions found in Kildeer Plain.

HYMENOPTERA—FORMICIDAE

Subfamily PONERINAE

This group is listed first because it represents the most primitive of all the *Formicidae*, and it may well be that the Ponerines represent the ancestral stock of the more highly specialized subfamilies. Its species are found in greater abundance in the tropic than in the temperate zone. Some species of *Ponerinae* are found quite frequently, but even then, their nesting sites are much more inaccessible than those of other species.

The colonies are small and the nests are always found in well-protected, damp places such as decaying wood and damp soil which may be found under rocks and boards.

---

[3] Sears, P. B. 1926. The natural vegetation of Ohio. Ohio Jour. Sci., 26, page 137.

[4] Identification of the flora of the region by Dr. Earl L. Core of West Virginia University, Morgantown, West Virginia.

The subfamily *Ponerinae* is easily recognized by the presence of a distinct constriction between the first and second segments of the gaster and also of a large, well developed sting.

Genus **Ponera** Latreille

Ponera coarctata subsp. **pennsylvanica** (Buckley).

Ponera pennsylvanica Buckley. 1866. Descriptions of new species of North American Formicidae. Proc. Entom. Soc. Phila., 6: 171. (Worker.)

Workers and males of this ant were taken both in the woods and in the open field. Workers were found under bark and in partially decayed oak. The males, with a few workers, were found in August in the deep hummock of a prairie field. The colonies of this slender species of ant are very small. There are seldom more than forty or fifty workers with five to fifteen pupae during brood rearing.

Subfamily MYRMICINAE

This subfamily, while not as primitive as the *Ponerinae*, is also of the more primitive type.

Representatives of the various genera are found in a variety of habitats and in many sections of the country. The species vary greatly in size, color, and size of colony. Some, because of their numbers and place of abode, get to be pests, as in the case of *Monomorium pharanois* (Linnaeus).

Most members of this subfamily also have large, well developed stings as were present in the *Ponerinae*. Instead of having a well developed constriction beyond the first segment of the gaster, as in the Ponerines, this segment is clearly separated off, so that the pedicel consists of two highly specialized segments, which is the outstanding mode of identification of all *Myrmicinae*.

Genus **Crematogaster** Lund

Crematogaster lineolata (Say)

Myrmica lineolata Say. 1836. Descriptions of new species of North American Hymenoptera and observations on some already described. Bost. Jour. Nat. Hist. I: 290. (Worker, female, male.)

This rather common species is found to nest in many situations. It was found in woods, in open fields nesting in hard, dry clay and in moist soil. Winged males and females were taken in July.

The nesting sites of this ant, as found here in the prairie, provide an illustration of insect adaptation to an environment. Here in the prairie where there is not an abundance of dead wood, it must by necessity find other nesting sites, if it is to survive.

Crematogaster lineolata var. **cerasi** (Fitch).

Myrmica cerasi Fitch. 1854. Trans. New York State Agric. Soc. XIV. p. 835. (Worker.)

This variety is slightly lighter in color than the previous one, otherwise is similar. It was taken from dead elm and oak trees. A very large colony, including workers, winged males and females, was taken in August, also from a dead elm.

Genus **Solenopsis** Westwood

Solenopsis molesta (Say).

Myrmica molesta Say. 1836. Descriptions of new species of North American Hymenoptera and observations on some already described. Bost. Jour. Nat. Hist. 1: 295. (Worker.)

The thief ant, by which name this minute species is sometimes known, is found in almost any type of surroundings. It lives independently or as a thief in other formicaries. It has been found in grass, in mounds, under stones all of which may be in moist or in dry places. It has been taken in this area in association with Myrmica and Formica, particularly on the tops and sides of the mounds they build. The colonies frequently become quite large. Winged males and females were taken during July and August.

Genus **Myrmecina** Fabr.

Myrmecina graminicola subsp. **americana** var. **brevispinosis** Emery.

Myrmecina latreillei subsp. *americana* var. *brevispinosa* Emery. 1894. Zool. Jahrb., Abth. of Syst., 8: 271. (Workers, females, males.)

The one small colony which was taken was found nesting in a crevice under the bark of elm in a damp, shady woods. It prefers shady, rather moist habitats.

Genus **Leptothorax** Mayr

Leptothorax longispinosus Roger.

Leptothorax longispinosus Roger. 1863. Die neue aüfgefuhrten Gattungen und Arten meines Formiciden Verzeichnesses. Berl. Ent. Zeitschr., VII, p. 180, No. 69. (Worker.)

A small, black species which is usually found nesting in tight places. Small colonies were taken from this area in the crevices of bark on living oak in the woods. Winged females were found in August in the scaly bark of elm.

Leptothorax fortinodis Mayr.

Leptothorax fortinodis Mayr. 1886. Die Formiciden der Vereinigten Staaten von Nordamerika. Verh. Zool.-bot. Ges. Wien. XXXVI, pp. 451, 452. (Worker, female.)

At no time was an entire colony of this species taken. A few stray individuals were found on the bark of oaks at various times, and twice they were found as strays in the open field.

Leptothorax curvispinosus Mayr.

Leptothorax curvispinosus Mayr. 1866. Sitz. B.k. Akad. Wiss. Wien, 53: 508. (Worker.)

The few stray ants of this species, which were observed, were wandering on vegetation at the edge of the woods.

Leptothorax curvispinosus subsp. **ambiguus** Emery.

leptothorax curvispinosus subsp. *ambiguus* Emery. 1895. Beiträge zur Kenntniss der Nordamerikanischen Amneisenfauna. Zool. Jahrb. Abth. f. Syst., VIII, pp. 317, 320. (Worker.)

Most of these small yellow ants were found as strays in the woods and in the open field. A few were found in the mounds of *F. neocinerea*. One nest with forty-four workers and a deälate queen was taken from a hummock in a field, during August. The firm, clay hummock was completely covered over with clover.

Genus **Myrmica** Latreille

Myrmica scabrinodis lobicornis var. **fracticornis** Emery.

Myrmica scabrinodis lobicornis var. *fracticornis* Emery. 1895. Zool. Jahrb. Syst. Vol. 8, p. 313. (Worker.)

This small, dark colored ant was taken abundantly in shallow, grass covered mounds of the prairie. It was found independently in mounds and was collected several times at the base of *F. neocinerea* mounds. With but one exception, it was always found where there was moisture, and was occasionally found in very wet clay. Winged males and females appear during August and were taken abundantly. This was one variety that was found in the moist furrows of newly plowed fields. Since the varieties of *M. scabrinodis* are so similar, there is some doubt as to the identification.

Myrmica scabrinodis sabuleti var.?

(This form is recognized by Dr. Neal A. Weber in an unpublished monograph of the genus Myrmica.)

This ant is quite similar to *M. fracticornis* Emery, except for a slight variation in the frontal carina. This variation is so slight that it offers difficulties, consequently identification of this species is also uncertain. This variety, not as common as *M. fracticornis*, was collected only once. The nest, which contained winged queens, was located in a small grass-covered mound, in a field.

Genus **Aphaenogaster** Mayr

Aphaenogaster fulva subsp. **aquia** (Buckley).

Myrmica (*Monomerium*) *aquia* Buckley, S. B. 1867. Descriptions of new species of North American Formicidae. Proc. Ent. Soc. Philad. 6: 341. (Worker, female.)

A moist blue grass-clover situation provided the habitat for the few times this subspecies was found in the open field. At no time was a nest observed in the area, the few specimens having been taken as strays.

Subfamily DOLICHODERINAE

There are comparatively few species in this subfamily, but they have a wide range of habitat.

In this subfamily the pedicel consists of but a single segment which is not vertically protuberant, and there is no constriction between segments in the gaster. The sting is vestigial or absent.

Genus **Dolichodorus** Lund

Dolichoderus plagiatus (Mayr).

Hypoclinea plagiata Mayr. 1870. Neue Formiciden Verh. Zool.-bot. Ges. Wien. 20: 957–960. (Worker.)

This ant was taken only once, and then just a few workers were found on a smilax vine which was growing on an elm tree at the edge of the woods. It is easily distinguished by the epinotal shelf or hood and by the presence of a coarsely puntcate head and thorax and lighter spots on the abdomen.

Genus **Tapinoma** Forster

Tapinoma sessile (Say).

Formica sessilis Say. 1836. Descriptions of new species of North America Hymenoptera and observations on some already described. Bost. Jour. Nat. Hist. 1: 287–288. (Worker, female.)

A wide-spread species, it is found to nest in varied circumstances. It was taken in the open field, in woods, under stones, on the bark of trees, in sunshine and in shade. The larvae and pupae of this ant are dull orange in color, and when an entire nest is uncovered it frequently emits a peculiar odor which has often been called a "rancid butter odor."

Subfamily COMPONOTINAE

The species represented in this subfamily are more highly developed in habits than some previously mentioned. The number of species is large and each genus is highly subdivided. In this subfamily we have represented some of the largest known ants as well as one of the smallest.

The pedicel in this group consists of only one segment and the sting is either vestigial or absent.

Genus **Brachymyrmex** Mayr

Brachymyrmex heeri subsp. **depilis** Emery.

Brachymyrmex heeri Forel subsp. *depilis* Emery. 1893. Beiträge zur Kenntniss der Nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 635. (Worker, female, male.)

One of the smallest ants, it is known to nest in shady places, under stones, in cool, moist sites. Each time it was found on the prairie it was located in plowed furrows of cool, moist earth, which were at least eight inches deep. Its distribution is probably widespread here, but due to its nesting habits, it was not found frequently.

Genus **Camponotus** Mayr

Camponotus hecurleanus subsp. **pennsylvanicus** (DeGeer).

Formica pennsylvanica DeGeer. 1773. Mem. Serv. Hist. Insect., 3: 603, Pl. 31. Figs. 9–10. (Workers, females, males.)

This ant shows a wide range of adaptability to temperature and moisture. It is by far the most abundant *Camponotus* in the Middle West. Each time this species was taken in the oak-hickory woods at the edge of the prairie, it was found in partially decayed logs and stumps. Once it was found as a stray in the open field about twenty-five feet from a poplar tree, wandering about in the grass.

Camponotus caryae (Fitch).

Formica caryae Fitch. 1855. Trans. N. York State Agri. Soc. 14: 855–859. (Worker, female, male.)

Loose bark of trees and hollow twigs formed the nests for this species. At no time were large numbers taken, because the individuals of a colony on being disturbed scatter quickly. Winged females were found in August.

Genus **Lasius** Fabricius

Lasius niger subsp. **alienus** var. **americanus** Emery.

Lasius niger (L.) subsp. *alienus* Forster var. *americana* Emery. 1893. Beiträge zur Kenntniss der Nordamerikanischen Ameisenfauna, Zool. Jahb. Abth. Syst. Vol. 7, p. 639, pl. 22. (Worker, female, male.)

This ant is the most common and most abundant of all ants and is found in nearly all parts of North America. It displays evidence of indifference in the location of its nesting sites, for it has been found in this prairie region each time collecting was done and in all types of habitat. In the woods it prefers damp logs for its nesting sites, while in the prairie proper, it nests in the soil. Winged males and females were found abundantly in August.

Lasius umbratus subsp. **mixtus** var. **aphidicola** (Walsh).

Formica aphidicola Walsh, B. D. 1862. On the genera of aphidae found in the United States. Proc. Ent Soc. Philad. 1: 310. (Worker, male.)

The colonies of this variety cultivate root aphids and coccids. It is undoubtedly because of this characteristic that these ants were found in the moist roots of grass which was growing at the base of trees in the woods. Collections were also made from logs in the woods and from mounds located near a ditch at the edge of the woods.

Genus **Formica** Latreille

Formica fusca var. **subsericea** Say.

Formica subsericea Say, T. 1836. Bost. Jour. Nat. Hist., 1: 289. (Worker, female.)

Workers of this species were taken all through the woods in partially decayed logs, in mounds at the edge of the woods and along roadside ditches. They were encountered quite frequently, for the ant is common in the region.

Formica pallidefulva subsp. **nitidiventris** Emery.

Formica pallidefulva Latreille var. *nitidiventris* Emery. 1893. Beiträge zur Kenntniss der Nordamerikanischen Ameisenfauna. Zool. Jahrb. Abth. Syst. Vol. 7, p. 672, pl. 22. (Worker.)

Most of these ants were found in the open field, but always in places protected by stones and hummocks. They were also found on the slope of Tymochtee Creek under stones which were shaded by trees. Winged queens were taken in July.

Formica pallidefulva subsp. **nitidiventris** var. **fuscata** Emery.

Formica pallidefulva subsp. *fuscata* Emery. 1893. Beiträge zur Kenntniss der Nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 656. (Worker, female.)

Only a few workers of this variety were found in the region, and these on the bark of an oak in the dense forest. This species resembles very closely *F. nitidiventris*, except that it is slightly darker.

Formica pallidefulva Latreille subsp. **schaufussi** Mayr, var. **incerta** Emery.

Formica pallidefulva schaufussi var. *incerta* Emery. 1893. Beiträge zur Kenntniss der Nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 655–656. (Worker, female, male.)

These were found as strays in the open field and also at the edge of the woods

Formica cinerea var. **neocinerea** Wheeler.

> *Formica cinerea cinerea*, var. *neocinerea* Wheeler. 1913. A Revision of the Ants of the Genus Formica (Linne) Mayr. Bull. Mus. Comp. Zool. Harvard, Vol. 53, p. 399, 524. (Worker, female, male.)

This variety so closely resembles *F. rutilans* and *F. montana*, that it is quite difficult to make a distinction except for slight color variations. It is often called a prairie ant, for in the natural hummocks it finds a perfect nesting place. This is the ant which is found most conspicuously in the Kildeer Plain area, and in some fields is found in almost a pure *F. cinerea neocinerea* community.

The mounds are numerous and are quite close together. They vary in size, but generally are about six or eight inches high and about twenty inches broad. The largest mound noted was at least ten inches in height and thirty-six inches in length.

The bases and sides of the mounds usually are grass-covered and the tops are nearly always barren. Some have been found where the tops of the mounds also were grass-covered. The mounds which are free of grass on top, generally have a thin layer of debris there. This debris is composed of dry twigs, fragments of grass and possibly materials brought up from the mound.

Sixty-five such mounds were opened and all but four were found in the prairie in typical *neocinerea* communities. The remaining four were found at the edge of the forest.

One very interesting thing was noted in the fact that twenty of these mounds were built at the base of thistle. The live thistle either protruded from the mound or was found at the side. That the presence of these live thistle plants is of any consequence is uncertain, but it appears far from being coincidental, since almost a third of the mounds presented this feature.

There is a possibility that the honey-dew secreted by the aphids which dwell upon this thistle (*Circium lanceolatum* L.) furnishes the motive in this association, for frequently *F. cinerea neocinerea* has been observed on the plants, which harbored aphids, in great numbers.

The necessity of mounds for this variety of ant is not positive but it seems likely that they are a refuge and protection in periods of excess moisture, since drainage is poor. The nests themselves extend into the soil to the water table, a depth of severel feet. They may dwell either below the surface level or above in the mound, as necessity demands.

A greater choice of temperatures for brood rearing occurs in a mound superimposed on underground galleries. The temperature at various places within a mound is unequal, thus making it possible for the brood to be moved to warmer and cooler areas, as may be necessary.

Formica cinerea var. **rutilans** Wheeler.

> *Formica cinerea* var. *rutilans* Wheeler. 1913. A revision of the ants of the Genus Formica (Linne) Mayr. Bull. Mus. Comp. Zool. Harvard 53: 399, 525–526. (Worker.)

This variety was located in three nesting sites: in a newly plowed field, a mound in the prairie resembling that of *F. neocinerea* and in a small mound at the edge of the woods. Due to the similarity of this ant to *F. neocinerea* in both appearance and habits, it is difficult to identify, consequently, this identification is uncertain. It was not observed abundantly in the region.

Formica montana Emery.

> *Formica subpolita* var.? *montana* Emery. 1893. Zool. Jahrb. Syst., Vol. 7, p. 663.

This ant is extremely difficult to distinguish from *F. neocinerea* and *F. rutilans*, for both the ant and the mound resemble these two species.

The mounds which were opened were found in the same field scattered among the *F. neocinerea* mounds. These mounds were present also at the base of thistle. The habitats of these ants seem to be identical.

Formica ulkei Emery.

> *Formica ulkei* Emery. 1895. Beiträge zur Kenntniss der Nordamerikanischen Ameisenfauna. Zool. Jahrb. Syst. 7: 663, pl. 22, fig. 7. (Worker.)

This ant belongs to the *exsectoides* group which is distinguished by having the head of the worker and the female deeply excised behind.

The mounds which this ant builds resemble greatly the mounds built by *F. neocinerea*, but they are distinguished by their general shape. The *F. ulkei* mounds are much rounded on top and as they continue to grow, they are built in height as well as in width. The *neocinerea* mounds, in contrast, have the tops flattened and grow chiefly in width.

The location of the *ulkei* mounds shows a marked difference, for this species prefers to nest at the edge of the woods or along roadsides and ditches where there is a constant supply of moisture.

DISCUSSION

1. *Formica cinerea neccinerea* is by far the outstanding ant in this Kildeer Plain area, both with reference to the size of the colonies and its widespread distribution in the region.
2. The species of ants in the area are determined in part by the topography of the region, the amount of moisture, and the materials which can be used for nesting places.
3. On the edge of the plain where slopes and wooded areas are included, the number of species increases in proportion to the materials which can be used for the nests of colonies.
4. Many of the ants commonly found in other parts of the state are not found here, or are rarely found, due to restrictions in the environment.

BIBLIOGRAPHY

Britt, W. E. 1916. Hymenoptera of Connecticut. State Geological and Natural History Survey. Bulletin No. 22.

Dennis, C. A. 1937. The Distribution of Ant Species in Tennessee with Reference to Ecological Factors. Reprints from Abstract of Doctor's Dissertation, No. 24. The Ohio State University Press.

Madison, H. L. 1938. Wild Flowers of Ohio. The Cleveland Museum of Natural History, Cleveland, Ohio.

Morrison, T. M. 1918. Soil Survey of Marion County, Ohio. Advance Sheets, Field Operations of the Bureau of Soils.

Olson, H. W. 1928. The Earthworms of Ohio. Ohio Biol. Survey. Vol. IV, No. 2. Bulletin No. 17, 47–90.

Robinson, B. L., and M. L. Fernald. 1908. A Handbook of Flowering Plants and Ferns of the Central and Northeastern United States and Adjacent Canada. Gray's New Manual of Botany. (Seventh Edition, Illustrated.)

Sears, P. B. 1925. The Natural Vegetation of Ohio. Ohio Jour. Sci. 25: 139–149.

1926. The Natural Vegetation of Ohio. Ohio Jour. Sci. 26: 128–146.

1926. The Natural Vegetation of Ohio. Ohio Jour. Sci. 26: 213–232.

Shelford, V. E. 1913. Animal Communities in Temperate America. The Geographic Society of Chicago. Bull. No. 5.

Talbot, Mary. 1934. Distribution of Ant Species in the Chicago Region with Reference to Ecological Factors and Physiological Toleration. Ecology, Vol. 15, No. 4, pp. 416–439.

Thompson, Isabel. 1939. Geographical Affinities of the Flora of Ohio. The American Midland Naturalist. Vol. 21, No. 3, pp. 730–751.

Transeau, E. N., and P. E. Williams. 1928. Distribution Maps of Certain Plants in Ohio. Vol. 4, No. 5. Bull. No. 20, pp. 181–217.

Winchell, N. H. 1873. Geology of Wyandot County, Chap. 28 Report of the Geological Survey of Ohio. Vol. 1.

Wheeler, W. M. 1903. A Revision of the North American Ants of the Genus Leptothorax Mayr. Contributions from the Zoological Laboratory of the University of Texas, No. 48.

1910. The North American Ants of the Genus Camponotus Mayr. Annals N. Y. Academy of Sciences. Vol. 20, No. 6, Part 11, pp. 295–354.

1913. A Revision of the Ants of the Genus Formica (Linne) Mayr. Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 50. No. 10.

DROSOPHILA CULTURE WITH A MINIMUM OF AGAR

WARREN P. SPENCER,
Department of Biology, Wooster College,
Wooster, Ohio

Since the early days of *Drosophila* culture, agar has served as an important ingredient of standard Drosophila media. At present agar stocks in many *Drosophila* laboratories are rapidly nearing depletion. Reduced laboratory personnel, the prohibitive price of agar and the prior claims on it for important bacteriological work constitute a serious problem. However, it seems patent that the Drosophila work should be continued at least to the extent of preserving valuable stock cultures which represent many years of careful work and which could in many cases not be replaced if once lost. For years the author has been particularly interested in culture methods, and therefore makes some suggestions here which he hopes may be helpful.

Stock cultures of the various *Drosophila* species are best kept in containers at least as large as quarter pint bottles and preferably in half pint bottles rather than in vials. The larger containers with larger food mass provide a margin of safety where reculturing is not done strictly on schedule. It is important to use enough adult flies in making up a fresh culture so as to eliminate chance of losing the culture through the accidental death or sterility of a few of the parent flies. As the adult flies feed on solid or semi-solid surfaces and do not burrow into media their food supply is determined by total exposed surface and not by volume of food. However, as flies easily become mired in soft food a medium with an agar base is by far the most convenient and satisfactory. Some laboratories have with some degree of success increased the corn-meal and oat-meal content of the medium and reduced or eliminated the agar content. However, such media are difficult to pour and not entirely satisfactory. For stock cultures we have reduced the agar content somewhat, but pour only a thin layer of medium about one fourth inch deep in half pint bottles. This gives the same feeding surface for adults as medium poured to a depth of an inch and a half. In this way we can pour from 125 to 150 half pint culture bottles with the use of 25 grams of agar. Then after a week or somewhat longer in case of slow breeding species a plentiful supply of food is added for the young larvae. This food contains no agar. It may consist of chunks of corn-meal, Karo, yeast mixture or more frequently we use a sheet of facial tissue dipped in a fresh suspension of baker's yeast in water, about 100 grams of yeast to 600 cc. of water. Thus on a minimum of agar adult flies are provided adequate surface for feeding and later larvae are supplied adequate volume of food. With this procedure there is no difficulty encountered in reculturing as the food mass has formed a cake which does not easily shake loose by the time a new generation emerges.

For experimental cultures (but not for stocks) the following method is used. Corn-meal, Karo, agar medium enriched with brewer's yeast is made up and poured into suitable containers such as large covered glass dishes or aluminum pans. As Moldex is used, dishes of this medium may be kept in the refrigerator for a week or longer. A supply of cardboard parallelograms about an inch and a half long and cut on the bias is made up. A dish of medium is turned out onto a flat tray and cut into blocks about one inch long and a quarter inch thick. Cardboard strips and blocks of medium are of a width to fit into the size of vial used. Blocks of medium are placed on the cardboard strips and a drop of heavy yeast suspension added. For convenience in handling, glass vials are held together in sets of seven with rubber bands. These vials are set out on the table, pairs of etherized flies dropped into them and then the vials are turned on their sides, cardboard strips with medium inserted, vials plugged and placed in the horizontal position in trays, and allowed to stand for the deposition of eggs and emergence of young larvae. After several days the vials are unplugged, parent flies released, and with forceps the cardboard strips are removed. Into each vial is poured a suspension of baker's yeast in water (see above), and a sheet or part of a sheet of facial tissue folded once and pushed down to the bottom of the vial. For a large vial 100 mm. x 15 mm., one fourth full of yeast suspension, a double sheet of facial tissue will absorb the liquid. The tissue should then be pulled back slightly from the bottom of the vial to ensure the complete soaking up of the liquid medium. The cardboard strip containing medium, eggs and larvae is then dropped in on the paper and the vial replugged and set in an upright position.

The larvae burrow very readily all through the paper base, provided too much yeast suspension has not been used. Experience will indicate how much paper and yeast suspension to use for vials of different sizes. Pupation takes place mostly in the paper. By this method the yield per vial is large, the flies are of uniform size, reach maximum size for the species, and owing to the abundant and easily available food supply larval competition is cut to a minimum. There is less spread in the emergence period than with other media. However, flies should be examined within two or three days of emergence as the paper-yeast suspension is not an adequate diet for adults. A small piece of fresh solid medium added after pupation will keep the adults over if they cannot be examined soon after emergence.

For some years I have used the method described above for all experimental cultures. For such large species as *Drosophila hydei*, *D. robusta*, and *D. funebris* yields of 300 flies per vial are not uncommon, and the average yield is over 150 flies. Furthermore, vials are more easily cleaned than where agar medium has been poured into them. Even where there is an abundant agar supply the author recommends this procedure for experimental cultures. In case agar supplies are depleted, thick corn-meal or other culture media which are difficult to pour might readily be cut into blocks for use as described above.

Floriculture

This book is described by its authors as ". . . a text for the teaching of a course dealing with ornamental plants." It will serve this purpose well. Approximately 140 pages are devoted to lists, keys, and tables of the characteristics, requirements, and floricultural uses of ornamental plants. The extensiveness of these lists will make the book valuable also to commercial ornamental plantsmen as a reference manual. The primary list of each kind of plant is arranged alphabetically according to taxonomic family. It is unfortunate that the authors, trained scientists, were not completely successful in avoiding the layman's unscientific practise of ascribing the capacity for human emotion to plants: on page 9, "suffer;" on pages 231, 339, and 402, "prefer;" and on page 324, "partial to." The seed is incorrectly defined as a "ripened ovary" on page 164. No other errors of definition were noted. The loose language of popular catalogues found its way into the descriptions of hardy waterlilies. Of the variety Attraction it is stated, "This is the largest hardy lily, . . ." while of *Odorata sulphurea grandiflora* it is stated, "This is the largest of all hardy lilies. . . ." All the illustrations are line drawings of only fair quality. Figure 49 does not show what the text describes for a side graft. Besides nine chapters on particular groups of plants, there are ten others including the following titles: Soils, Fertilizers, Soilless Culture, and Greenhouse Management.—*Elton F. Paddock*.

Floriculture: Fundamentals and Practices, by A. Laurie and V. H. Ries. 496 pp., with 67 illustrations. The McGraw-Hill Book Company, New York, 1942. $4.00.

RECORDS OF ANOSTRACAN PHYLLOPODS IN NORTHEASTERN OHIO

RALPH W. DEXTER AND LESLIE E. SHEARY
Kent State University

Records of anostracan phyllopods (fairy shrimps) in Ohio and adjoining regions are not very plentiful. Chambers (1874) reported *Eubranchipus vernalis* from a temporary pool near Covington, Kentucky, a few miles from Cincinnati. Hunt (1882) listed *E. stagnalis* for the Cincinnati region. Garman (1924) described *E. neglectus* from Kentucky. Baker and Rosof (1927–1928), who studied spermatogenesis in fairy shrimps, collected their specimens of *E. vernalis* in the Columbus region.[1] Ward (1940) reported *E. vernalis* from several pools near Cincinnati during the spring of 1938. No published accounts of anostracan phyllopods are known to the writers for northeastern Ohio. For older records in the known distribution of Anostraca, consult Packard (1883), Johanson (1921, 1922) and Creaser (1930a). For recent records of these sporadic organisms in eastern North America, see Dexter and Ferguson (1943). The present paper is concerned with studies on the seasonal and geographic distribution of *Eubranchipus vernalis* (Verrill) in the northeastern section of Ohio.

Preliminary field collections were made of the anostracan phyllopods in the vicinity of Akron, Ohio, during the late winter and spring of the years 1938–40. During the winter and spring of 1941 a restudy of the Akron area was undertaken with the addition of several new stations making a total of 17 in Summit County. Of these 17, six stations contained populations of *E. vernalis*. One of these ponds is known to have contained this species in 1936, 1938–1940. Two others are known to have had *Eubranchipus vernalis* in 1940. In addition, a rather extensive survey was made of Portage County, involving the examination of 80 temporary pools and ponds. Of these 80, seven stations were found to contain *Eubranchipus vernalis*, the only species of anostracan found in the two counties. This species has been previously reported from Massachusetts, New York, Pennsylvania, New Jersey, Kentucky, Ohio, Indiana, Michigan, Illinois and Ontario. Hence, 13 ponds out of a total of 97 studied, or 13.4 per cent, were inhabited by this fairy shrimp. In all but four cases the population was rather large and more so than reported from Illinois and Ontario by Ferguson (1939). However, a single specimen only was taken from two of the pools. In both of these cases the collection was made near the end of the fairy shrimp season (April 8).

The presence of fairy shrimps in two ponds near Canton, thirty miles south of Portage County, was reported to us by Mr. Charles H. Kuehnle in 1940. Subsequent collections of *E. vernalis* were made there in the spring of 1940 and 1941. One of these ponds contained the largest population of fairy shrimp found in our studies. Other records were also reported from near Canton. These reports were investigated in 1942, and the findings will be published in a later paper. The presence of fairy shrimps near Wooster was also reported to the writers, but no specimens have been collected by them there.

E. vernalis was one of two species reported by Ferguson (1939) and Dexter and Ferguson (1943) from east central Illinois. The other species, *E. serratus*, the more abundant and widely distributed species there, which has also been reported from Missouri and Nebraska, was not found in our northeastern Ohio studies.

---

[1] The specimens were collected in a pond near the campus of Ohio State University. The university later bought the property and drained the pond. No other published records of *E. vernalis* are known for the vicinity of Columbus. Personal communication from Dr. R. C. Baker, Department of Anatomy, the Ohio State University.

One pool in Summit County contained specimens of *Eubranchipus vernalis* in the spring of 1940, but did not have them in 1941. It was also observed that they disappeared there early in the season of 1940, sometime before April 13. Apparently conditions were not favorable as the fairy shrimps continued for several weeks in all other pools which had them in this region, and reappeared abundantly in those pools the following year. No pool lacking fairy shrimps when examined in 1940 was found to contain them in 1941.

The geographic distribution can readily be seen by reference to figure 1. The distribution was widely spread and sporadic. In only two cases were fairy shrimps found in closely adjoining pools. In most cases pools having shrimps were surrounded by pools not having them.

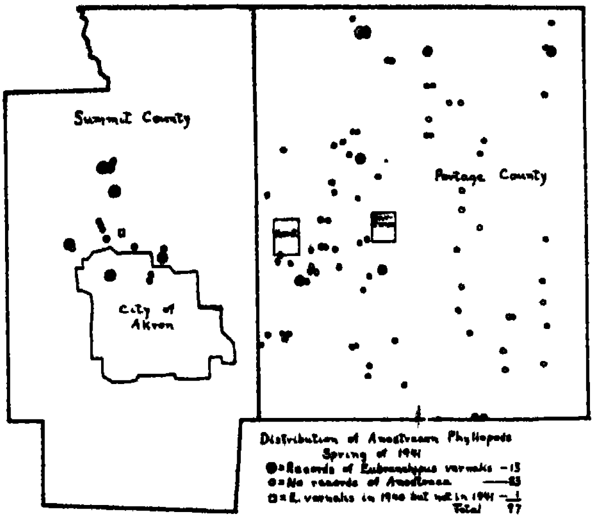

Summit County
City of Akron
Portage County
Distribution of Anostracan Phyllopods
Spring of 1941
● = Records of Eubranchipus vernalis – 13
○ = No records of Anostraca ——83
□ = E. vernalis in 1940 but not in 1941 – 1
Total 97

FIG. 1. Distribution of *Eubranchipus vernalis* in Portage and Summit Counties.

All specimens were collected in temporary pools or ponds of clear, cold water from winter rains and melted snow and ice. Metanauplii were collected with a plankton net, and adults with dip nets. Those pools which were frozen over during the early collections, and from which samples had to be taken through the ice, were revisited later after thawing for a more thorough sampling. Several stations containing phyllopods were visited every week until the fairy shrimp disappeared. Most of the pools were found in pastures and field corners and were of the typical "grassy" type as noted by Shelford (1913), but several were of the cattail type, and some were in ditches along roads and railroads (see figure 2 and cf. Dexter and Ferguson, 1943). Creaser (1929) found Eubranchipus most abundantly in woodland pools, and occasionally in pools which did not completely dry up. Mathias (1937) claimed that some phyllopods are found in permanent bodies of water. One of our collections came from a pond which very seldom dries up completely although a broad margin is dry each summer.

Ferguson (1935, 1939) reported *E. vernalis* in Ontario as being found only in the deeper pools. This may be due to the thick ice that sometimes forms in that region. Many of the Ohio records reported here are from shallow pools no more than one foot in depth. Two of the pools, on the other hand, were several feet deep, one having a depth of nearly five feet. Specimens were found in temper-

Fig. 2.
Typical grassy, cattail, and ditch type of fairy shrimp habitats.
(Photos by R. W. Dexter.)

atures ranging from 0° to 22° C. The senior author (ibid.) found *Eubranchipus serratus* in Illinois to tolerate water temperatures up to 23° C.

During night collecting it was discovered that *E. vernalis* is positively phototropic to the light of an ordinary flashlight, and that salamanders and leeches prey upon the fairy shrimps consuming large numbers. Creaser (1929) suggested that probably amphibians are important factors in controlling the numbers of fairy shrimps. Pearse (1913) and Mathias (1937) have listed the principle enemies of fairy shrimps to be tadpoles, frogs, salamanders, dytiscid, hydrophyllid, and gyrinid beetles, phryganeid caddis larvae, and water birds.

The winter of 1939–40 was cold and was followed by a late spring. The earliest record of metanauplii was taken on March 3; the earliest record of adults was taken on March 19. The latest collection was made on May 26. The winter of 1940–41 was mild, and was followed by an early spring. The earliest record of metanauplii was taken in mid-December; the first adults were collected on February 1. The latest collection was made on May 4. Several of the pools which had contained phyllopods were dried up by May 3 and 4, and all of the Portage County pools no longer contained specimens. Several of the deeper Summit County pools contained small but rapidly diminishing numbers. As in the case of the Illinois populations studied by the senior writer, a second or late brood was detected in many of the pools after the first population had reached maturity.

This study has demonstrated the same type of habitat and seasonal and geographical distribution of *E. vernalis* in northeastern Ohio as reported for *E. serratus* in east central Illinois. It shows again the sporadic nature of anostracan phyllopod distribution, the direct relation of temperature to life history and life span, and the influence of weather on seasonal occurrence.

The writers wish to thank Dr. M. S. Ferguson for a critical reading of the manuscript.

LITERATURE CITED

Baker, R. C. and J. A. Rosof. 1927–28. Spermatogenesis in *Branchipus vernalis*. Ohio Jour. Sci. 27: 175–183; 28: 50–68; 315–328.

Chambers, V. T. 1897. Our fresh water Entomostraca. Cincinnati Quart. Jour. Sci. 1: 22–26.

Creaser, E. P. 1929. The Phyllopoda of Michigan. Papers Mich. Acad. Sci., Arts, and Letters 11: 381–388.

1930a. Revision of the Phyllopod Genus Eubranchipus, with the description of a new species. Occas. Papers, Museum of Zool., Univ. of Mich. no. 208: 1–13.

1930b. The North American Phyllopods of the genus Streptocephalus. Occas. Papers, Museum Zool., Univ. of Mich., no. 217: 1–10.

Dexter, R. W., and M. S. Ferguson. 1943. Life history and distributional studies on *Eubranchipus serratus* Forbes. Amer. Midl. Nat. 29(1): 210–222.

Ferguson, M. S. 1935. Three species of Eubranchipus new to Canada. Canad. Field Nat. 49(3): 47–49.

1939. Observations on *Eubranchipus vernalis* in southwestern Ontario and eastern Illinois. Amer. Midl. Nat. 22(2): 466–469.

Garman, H. 1924. A new phyllopod Crustacean from Kentucky. Trans. Ky. Acad. Sci. 1: 85–87.

Hunt, J. H. 1882. List of microscopic articulata, etc. In Synopsis of Cincinnati Fauna. Cin. Soc. Nat. Hist. 5: 185–194.

Johanson, F. 1921. The larger freshwater Crustacea from Canada and Alaska. III. Euphyllopoda. Can. Field Nat. 35: 21–30; 92–94.

1922. Euphyllopoda Crustacea of the American Arctic. Rept. Can. Arctic Exped. 1913-18. Vol. 7, pt. G, 34 pp.

Mathias, Paul. 1937. Biologie des crustacés Phyllopodés. Actualites Scientifiques et Industrialles 447. 1–107.

Packard, A. S 1883. A Monograph of the Phyllopod Crustacea of North America with Remarks on the Phyllocarida. 12th Annual Rept. U. S. Geol. and Geog. Surv. of the Ter., 1878, Pt. I: 295–592.

Pearse, A. S. 1913. Observations of the behavior of *Eubranchipus dadayi*. Bull. Wisc. Nat. Hist. Soc. 10: 109–117.

Shelford, V. E. 1913. Animal Communities in Temperate America. Chicago. 368 pp.

Ward, E. B. 1940. A seasonal population study of pond Entomostraca in the Cincinnati region. Amer. Midl. Nat. 23(3): 635–691.

PRE-ILLINOIAN GLACIATION IN SOUTHEASTERN OHIO

H. A. IRELAND
New Philadelphia, Ohio

This paper is not intended to prove pre-Illinoian glaciation in southeastern Ohio, but to present certain data that bear on the problem. These data, if taken with other known and published information, may eventually prove a greater extent of glaciation than heretofore recognized. Major purposes of the paper are to stimulate others to look for additional evidence and to encourage discussion.

Many isolated glacial erratics in northern and eastern Kentucky, beyond the Illinoian ice border, are generally recognized as evidence of pre-Illinoian glaciation. Two of the boulders are large. One at 720 feet elevation is estimated to weigh 3 tons, and the other at 925 feet elevation is estimated to have weighed 16 tons before it was blasted into fragments (1). The smaller pebbles and cobbles weighed from a few ounces up to 3 pounds (2). They probably mark the southern extension of a pre-Illinoian ice lobe, which occupied southern Ohio and northern Kentucky, the tentative boundary of which has been drawn by Jillson (2).

In southeastern Ohio erratic boulders have been described by Patton and Hicks (3). Many large cobbles several inches in diameter have been found southwest of Cambridge, Ohio, by C. H. Moses of Muskingum College at New Concord, and he continues to discover additional cobbles each year in the same area.

The writer has observed and collected rounded and subangular cobbles and pebbles of local rock and a few foreign cobbles of rotted rock at elevations from about 1000 to 1040 feet elevation. These occur in many localities within the Muskingum Valley, as: 5 miles northwest of New Philadelphia, near Winfield, 6 miles south of New Philadelphia, 10 miles east of New Philadelphia, and 10 miles north of Cambridge. The shape and composition of the rocks indicate that they have been transported, but examination of the sites excludes transportation by man. All erratics are at elevations too high to allow ice rafting as an explanation of their positions.

No pre-Illinoian glacial till has been found in Ohio. It is to be expected that erosion during the long interval of time since the retreat of the first ice sheet would remove the early till. It is quite probable that such has been accomplished, leaving scattered erratics as remnants of the till. Old till, deeply leached, with a thickness of 35 feet is found in northern Kentucky south of Cincinnati.

High-level cobbles have been found at 990 and 1020 feet elevation near Chester, W. Va., by Frank Leverett (4) and Paul Kuegle. Leverett also found gravel at an elevation of 1020 feet east of Freedom, Pa. The writer visited both locations in company with Paul Kuegle and John Chase, and found additional samples. The granite pebbles are deeply decayed. The granite cobble, about 8 inches in diameter found near Chester by Leverett and Kuegle, has a deep rind of weathering extending over an inch inward from the outside surface. The elevation, location, and deep weathering of the cobbles indicate deposition during a pre-Illinoian glaciation. Leverett (4) has described outwash deposits along the Allegheny and upper Ohio Rivers as far south as Bellaire, Ohio, as due to a pre-Illinoian ice sheet. Drainage was across the col at New Martinsville, W. Va., but the former drainage was resumed after the ice sheet retreated.

The cutting through of the major preglacial divide at Killbuck and Port Washington, and the reversal of northward drainage are results of pre-Illinoian glaciation, and prove that this early ice sheet entered northeastern Ohio. It may very probably have extended far into southeastern Ohio as well.

It is suggested, therefore, for the purposes of discussion and for stimulation of a renewed search for evidence, that a pre-Illinoian ice front extended from eastern Kentucky in a northerly direction across eastern Ohio. This boundary would then unite with the boundary of pre-Illinoian ice along the Allegheny River between Franklin and Warren in western Pennsylvania, as described by Leverett (4).

Leverett gives the age of the pre-Illinoian till in western Pennsylvania as equivalent to the Jerseyan till of the eastern United States, which is generally correlated with the Nebraskan of the central United States. The pre-Illinoian ice sheet of Ohio was probably Nebraskan.

REFERENCES

(1) **Jillson, Willard R.** Glaciation in Eastern Kentucky. Pan-Amer. Geol. 42: 125-132, 1924.

(2) ———. Early Glaciation in Kentucky. Pan-Amer. Geol. 44: 17-21, 1925.

(3) **Patton, L. T., and Hicks, Clifford.** Notes on the occurrence of glacial material beyond the border of drift in Muskingum County, Ohio. Ohio Jour. of Sc., 25: 98-00, 1925.

(4) **Leverett, Frank.** Glacial deposits outside the Wisconsin terminal moraine in western Pennsylvania. Pa. Geol. Surv., 4th Ser., Bull. G-7: 94-103, 1934.

AN OBSERVED INFESTATION AND TREATMENT OF PSOROPTES CUNICULI IN THE EARS OF LABORATORY RABBITS

JOHN HEFFELFINGER
The Ohio State University

From time to time laboratory rabbits have been observed to carry a parasitic infestation which produces a scabbing of the skin of the inner, proximal surface of the ear (Schwartz, 1928).[1]

An infested rabbit, which was being immunized against *Salmonella pullorum*, called particular attention to its condition because of the symptoms produced. The animal exhibited convulsions and loss of equilibrium. It held its head on one side, with the more heavily infested ear down.

Further investigation led to the recovery of a mite, which was tentatively identified as *Psoroptes cuniculi*. The parasite was present in large numbers in the heavily scabbed material in the outer ear, and to a lesser degree from the inner ear and semi-circular canals. The brain, which was recovered from this animal, is being prepared for further study although no microscopic lesions were noticed.

Treatment of the infestation before the inner ear is involved is very simple, consisting of swabbing the affected area with equal parts of 5% phenol and glycerol. The glycerol tends to soften the scabs so that they can be easily removed, and the phenol penetrates far enough to kill any mites left on the skin. In the majority of cases, two or three applications over a period of as many days have been efficacious in removing the mites.

---

[1] Schwartz, 1928, U. S. Department of Agriculture, Farmer's Bulletin No. 1568.

AN INVESTIGATION OF THE LINKAGE RELATIONSHIPS OF THE BLOOD GROUPS AND TYPES WITH HAND PATTERNS AND HANDEDNESS

D. C. RIFE AND H. WARNER KLOEPFER,
The Ohio State University

The blood groups and the M and N agglutinogen reactions are unique among known human traits, in that their modes of inheritance are simple and clear, they remain constant throughout the life of the individual, and all the genes involved are comparatively common in most populations. Such traits are ideal for linkage studies and they have probably been used for this purpose more frequently than any other human traits. (Finney, 3,4,5), (Penrose, 6,7), (Snyder, 10,11), (Weiner, 12).

Dermatoglyphics are similar to the blood reactions in that they remain constant throughout the life of the individual, that they have a genetic basis, and that the majority of the genes involved appear to be comparatively common in most populations. They differ from the blood reactions in that the number of genes involved and their reactions are not known, and that their expression is modified to a certain extent by circumstances in utero. All known dermatoglyphic features show some degree of intra-pair variation in identical twins, although these differences are much less frequent than those encountered within fraternal twins and sibs. (Rife, 8).

Functional handedness is, of course, a much more subjective trait than either the blood reactions or dermatoglyphics. Presumptive evidence of autosomal linkage between handedness and palm pattern D in the fourth interdigital area has been found, (Rife, 8), and would seem to definitely indicate a genetic basis for handedness although the mode of its inheritance is not fully understood.

The investigation reported here is concerned with tests for linkage of each of the blood reactions with handedness and hand patterns. The data were obtained from sibships within ten families of various sizes. Only unimanual handedness was considered, and classification was determined from the individual's testimony and by the performance of several operations, including throwing, sewing and driving a nail. Individuals performing one or more of these acts with the left hand were classed as left-handed, only those performing all one-handed operations with the right hand being classed as right-handers.

Five dermatoglyphic features are included in the tests. Figures 1, 2, and 3 show the appearance of each of the areas concerned. Palm patterns may be whorls, loops or vestigials. An area is considered patternless when all of the ridges run through to the margin of the palm (see Figs. 1 and 2). If Line C recurves to the margin of the palm between the triradii at the bases of the ring and little fingers, a loop is formed on the fourth interdigital area, if it recurves in the other direction, emerging between the triradii of the middle and ring fingers, a loop is formed on the third interdigital area. Main Line C is sometimes absent or abortive in one or both hands of an individual which accounts for the lower number of pairs recorded for Line C in Tables I and II. Whorls on finger-tips always have two triradii, loops one and arches none. As arches are comparatively infrequent, individuals are classed as to the number of whorls present, which varies from zero to ten.

Individuals are classed in three groups in respect to Line C, those forming patterns on the fourth-interdigitals of both hands, the third interdigitals of both hands, and the fourth interdigital on one hand and the third interdigital of the other. For the hypothenar, thenar and fourth interdigital Pattern D, individuals are classed as to presence or absence. Those having patterns on either or both are placed in the same category, as presence.

Within recent years several methods have been devised for detecting linkage in man, notably those of Weiner (12), Burks (1), Penrose (6, 7), Haldane (2), and Finney (3, 4, 5). The methods of Haldane and Finney can be applied only where we know the specific modes of inheritance of the traits concerned, and obviously are of no value in testing dermatoglyphics and handedness.

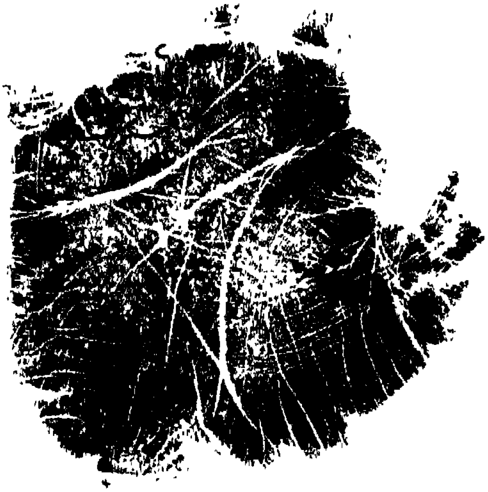


FIG. 1. Print of left palm. H indicates hypothenar area, T—thenar area, II—second interdigital area, III—third interdigital area, IV—*fourth interdigital area, C—main line C.* This palm shows a vestigial thenar pattern, a loop in the third interdigital area formed by main line C, and an accessory triradius in the fourth interdigital area, resulting in a D pattern. No patterns are present in the hypothenear and second interdigital areas.

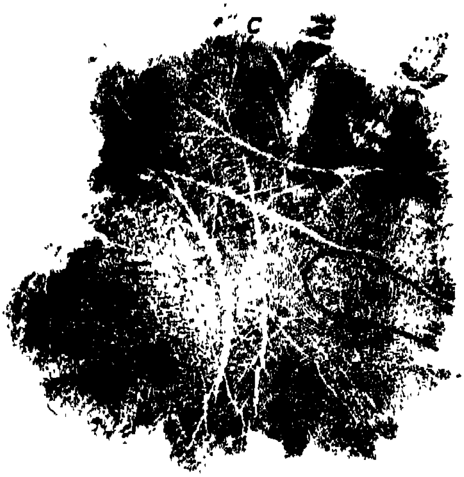


FIG. 2. Print of a right palm. No patterns are present on the thenar, second and fourth interdigital areas. Main line C forms a loop *in the third interdigital area, and an ulnar* loop is present on the hypothenar area.

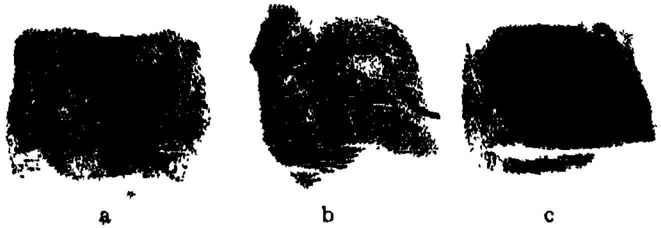


FIGURE 3. Types of finger patterns. a—arch, b—loop, c—whorl. Arches are characterized by the absence of triradii, loops have one, and whorls three. Both whorls and loops occur on palm pattern areas, loops being the most abundant pattern type in both fingers and palms.

Our tests are based upon the paired sib technique of Burks and Penrose, in which pairs are grouped into four classes: those alike in both traits, those alike in the first and unlike in the second, those alike in the second and unlike in the first, and those unlike in both traits. These are arranged in a 2 x 2 table, those alike in both and unlike in both forming one diagonal, and the two groups alike on one and unlike in the other trait forming the other diagonal. A modification was necessary in testing for linkage between whorls and the blood reaction, as whorls are quantitative. Pairs alike in blood reaction (Column 1, Table I) are classed as to number of intra-pair difference in whorls, (Column 2), as are pairs unlike in blood reaction (Columns 3 and 4). If pairs unlike in blood reaction show significantly greater intra-pair differences in whorls than do pairs alike in blood, it may be considered presumptive evidence of linkage.

Inspection of Tables I and II reveal only one significant Chi-square value, that of whorl frequency and the blood groups. However, pattern D and the M and N types show a Chi-square value of 3.44, only slightly below a significant level. We have consequently tested whorls versus blood groups, and pattern D versus the M and N types by means of Penrose's technique for graded characters.

TABLE I

	Alike in both traits	Alike in blood, different in other traits	Unlike in blood, alike in other traits	Unlike in both traits	Total pairs	X^2
	1	2	3	4		
Hypothenar....	95	81	45	29	250	0.59
Thenar........	132	42	63	13	250	1 50
Line C.... ...	37	54	16	22	129	0 02
Pattern D. . .	121	53	45	31	250	2 50
Whorls...... .	167	318	76	207	768	4.75
Handedness...	107	47	67	29	250	0.01

The above table shows the numbers of each of the various combinations of sib pairs used in testing for linkage between the blood groups and the various hand patterns and handedness. Chi-square values obtained are shown in the last column. Any X^2 value below 3.841 is not considered significant. Whorls differ from the other traits in the above classification, in that Column 1 gives the total number of pairs alike in blood group, Column 2 the total intrapair differences of those alike in blood, Column 3 the total number of pairs unlike in blood group, and Column 4 the total intrapair differences of those unlike in blood.

TABLE II

	Alike in both traits	Alike in blood, unlike in other trait	Unlike in blood, alike in other trait	Unlike in both traits	Total pairs	X^2
	1	2	3	4		
Hypothenar....	97	77	47	31	252	0.44
Thenar........	133	41	66	12	252	2.17
Line C.... .. .	40	59	20	22	141	0.63
Pattern D ...	119	56	43	34	252	3.44
Whorls........	165	439	80	204	888	0.07
Handedness....	108	45	67	32	252	0.24

Data used for testing linkage between M and N blood types and hand patterns and handedness. Whorls are classed as in Table II.

While there is no evidence of linkage for Line C and the blood reactions on the basis of the tests shown in Tables I and II, the fact that there are three classes of individuals in regard to Line C may raise some question as to the validity of that particular test. Thus, it was thought advisable to obtain a further check by the method for graded characters.

Table III shows no significant association for any of the traits compared. It seems justifiable on the basis of this study to conclude, therefore, that genes determining the blood reactions are probably located on different chromosomes from those determining handedness and hand patterns.

TABLE III

	ϕ	σ	$\frac{\phi}{\sigma}$
Whorls vs. Antigen A	.01	.24	0.08
Whorls vs. Antigen B	.04	.24	0.17
Pattern D vs. Antigen MN	.44	.246	1.79
Line C vs. Antigen A	.09	.27	0.30
Line C vs. Antigen B	.71	.47	1.69
Line C vs. Antigens MN	.08	.26	0.30

Values obtained in testing for linkage between the above traits by the Penrose method for graded characters. If $\frac{\phi}{\sigma}$ is less than two, the evidence for linkage is negative.

LITERATURE CITED

(1) **Burks B. S.** 1937. Yearbook, Carnegie Inst. of Washington, 36: 312.
(2) **Haldane J. B. S.** 1934. Annals of Eugenics, 6: 26–65.
(3) **Finney D. J.** 1940. Annals of Eugenics, 10: 171–214.
(4) ———. 1941. Annals of Eugenics, 11: 10–30.
(5) ———. 1941. Annals of Eugenics, 11: 115–135.
(6) **Penrose L. S.** 1935. 6: 133–138.
(7) ———. 1938. Annals of Eugenics, 8: 233–238.
(8) **Rife D. C.** 1938. Journal of Heredity, 29: 83–90.
(9) ———. 1941. Science, 94: 187.
(10) **Snyder L. H., Baxter R. C.** and **Kniseley A. W.** 1941. Journal of Heredity, 32: 22–25.
(11) **Snyder L. H.** 1941. Ohio Journal of Science, 41: 89–92.
(12) **Weiner A. S.** 1932. Genetics, 17: 325–350.

Nicholas Copernicus, Astronomer

On May 24, 1543, Nicholas Copernicus died. To stimulate interest in the preparation of programs and meetings commemorative of the quadricentennial of his death and provocative of thought over the period in which he lived, a brochure has been published by the Kosciuszko Foundation. This period was that in which modern scientific thinking first began to assert itself. The brochure is not merely an advertising medium, however. It is entirely worthy of consideration as an addition to one's library of truly authoritative and informative books. The story of Copernicus' life, his close relatives, the derivation of his name, and the significance of the Copernican Solar System concept which is generally accepted today the world over are interestingly and concisely presented. The excellent cover design in color is by the famous Polish miniaturist, Arthur Szyk. It depicts Copernicus among his most important inventions. Separate prints of the cover design on heavy paper suitable for framing are available at $1.00 each.—*Elton F. Paddock.*

Nicholas Copernicus, by Stephen P. Mizwa, A.M., LL.D. 88 pp. with 23 illustrations and colored cover design. The Kosciuszko Foundation, New York, 1943. 75 cents paper bound, $2.50 special bound and numbered.

ADDITIONS TO THE REVISED CATALOGUE OF OHIO VASCULAR PLANTS. XI.[1]

CLYDE H. JONES
The Ohio State University

Today the modern herbarium is playing an increasingly important part in the war effort. Many of our former sources of imports have been restricted or completely denied to us, and many of our native products have been depleted by vast exports. The botanist, therefore, is called upon more and more to aid in the search not only for new sources of materials but, also, for material from which synthetics can be manufactured.

It is a well-known fact that Germany has made such rapid strides in the field of synthetic vitamins that an internal collapse of that country due to vitamin starvation is a remote possibility. In many instances these advances have used basic discoveries made in the United States but never utilized here. The use of synthetic vitamins, however, has not yet proved entirely satisfactory. Consequently, the search for new and better sources of these important substances gains impetus. Achievements in this field can, in numerous cases, be traced directly or indirectly to botanists who have given freely of their knowledge of plants, their distribution, and their habitat requirements.

Amply supporting the preceding statement is a report submitted by the Soviet Scientists Antifascist Committee.[2] Research by the Soviet scientists in this field has ranged from the discovery of important vitamin C sources in wild rose hips, green walnut hulls, and pine needles to the publication of illustrated pamphlets dealing with wild-growing edible plants which raiding troops and guerillas might find behind enemy lines.

America is no longer complacent in respect to the field of new materials or that of synthetics. Herbariums throughout the country are receiving thousands of requests for information and specimens from investigators in the fields of medicine, chemistry, dietetics, agriculture, and manufacturing. For obvious reasons, detailed publicity cannot be given to this research at the present time.

To a major degree, credit must be given to the professional and amateur plant collectors for making such information available. Although they have been confronted with additional travel and employment regulations during the past year, these restrictions were not entirely without compensations. Many collectors who heretofore traveled throughout the State in search of rare plants have been forced to concentrate their efforts nearer home, with the result that many of these areas have yielded a wealth of hitherto overlooked species.

The following list of plants represents a majority of the new county and state records which have been added to the State Herbarium during the past year.

5. *Botrychium obliquum* Muhl. Oblique Grape-fern. New Franklin, Stark Co. Don M. Brown.

27.1. *Asplenium bradleyi* D. C. Eaton. Bradley's Spleenwort. Jacob's Ladder, Fairfield Co. Clyde H. Jones.

61. *Equisetum arvense* L. Field Horsetail. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.

126. *Typha angustifolia* L. Broad-leaf Cat-tail. Lawrence Twp., Stark Co. Don M. Brown.

157.1. *Eleocharis tenuis* (Willd.) Schultes var. *verrucosum* Sv. Higby Prairie, Ross Co. Floyd Bartley.

170. *Cyperus filiculmis* Vah. Slender Cyperus. Oneida, Carroll Co. Don M. Brown.

---

[1] Papers from the Department of Botany, The Ohio State University, No. 466.

[2] The Work of the Soviet Botanists. Science, Vol. 97, No. 2520. 1943.

175. *Cyperus erythrorhizos* Muhl. Red-rooted Cyperus. Jackson Lake, Jackson Co. Floyd Bartley.
218. *Carex canescens* L. Silvery Sedge. Yok Farm, Stark Co. Don M. Brown.
229. *Carex tribuloides* Wahl. Blunt Broom Sedge. Jefferson Twp., Clinton Co. E. E. Terrell, Jr.
230. *Carex cristatella* Britt. Crested Sedge. Paris Twp., Stark Co. Don M. Brown.
234. *Carex normalis* Mack. Larger Straw Sedge. New Franklin, Stark Co. Don M. Brown.
276. *Carex granularis* Muhl. Meadow Sedge. Yok Farm, Stark Co. Don M. Brown.
299. *Carex impressa* (Wright) Mack. Wright's Sedge. Morral, Marion Co. Don M. Brown.
300. *Carex lanuginosa* Mx. Woolly Sedge. Morral, Marion Co. Don M. Brown.
325. *Arundinaria gigantea* (Walt.) Chapm. Cane. Batavia, Clermont Co. M. B. Trautman via Edward S. Thomas.
341. *Festuca rubra* L. Red Fescue-grass. Paxton Twp., Ross Co. Floyd Bartley.
362. *Poa pratensis* L. Kentucky Blue-grass. Morral, Marion Co. Don M. Brown.
400. *Calamagrostis canadensis* (Mx.) Beauv. Bluejoint Reed Bentgrass. Marion Co. Clyde H. Jones.
409. *Cinna arundinacea* L. Wood Reed-grass. Stark Co. Don M. Brown.
409.1. *Cinna latifolia* (Trevir.) Griseb. Slender Wood Reed-grass. Ross Co Gordon S. Crowl.
415. *Phleum pratense* L. Timothy. Fairfield Co. Charles R. Goslin.
417. *Muhlenbergia mexicana* (L.) Trin. Mexican Muhlenbergia. Columbiana Co Don M. Brown.
419. *Muhlenbergia umbrosa* Scribn. Wood Muhlenbergia. Ross Co. Gordon S. Crowl.
421. *Muhlenbergia schreberi* Gmel. Spreading Muhlenbergia. Stark Co. Don M. Brown. Ross Co. Gordon S. Crowl.
422. *Brachyelytrum erectum* (Schreb.) Beauv. Brachyelytrum. Vernon Twp., Clinton Co. E. E. Terrell, Jr.
423. *Milium effusum* L. Tall Millet-grass. Pleasant Twp., Fairfield Co. Charles R. Goslin.
427. *Aristida dichotoma* Mx. Poverty-grass. Hocking Co. Don M. Brown.
428. *Aristida gracilis* Ell. Slender Triple-awned-grass. Guernsey Co. Emma E. Laughlin.
438. *Lolium multiflorum* Lam. Awned Darnel. Ross Co. Gordon S. Crowl.
438.1. *Agropyron cristatum* (L.) Beauv. Crested Wheat-grass. Franklin Co. Glenn W. Blaydes. Introduced.
442. *Triticum aestivum* L. Wheat. Y. M. C. A. Camp, Lake Co. Don M. Brown
444. *Elymus virginicus* L. Virginia Wild-rye. Canal Fulton, Stark Co. Don M. Brown
446. *Elymus canadensis* L. Nodding Wild-rye. Y. M. C. A. Camp, Lake Co. Don M. Brown.
447. *Elymus striatus* Willd. Slender Wild-rye. Clinton and Hamilton Co. E. E. Terrell, Jr.
448. *Hystrix hystrix* (L.) Millsp. Bottle-brush-grass. Wood Co. R. E. Shanks. Berne Twp., Fairfield Co. Charles R. Goslin.
449. *Hordeum vulgare* L. Common Barley. Wood's Cottage, Stark Co Don M. Brown.
453. *Spartina michauxiana* Hichc. Tall Slough-grass. Canal Fulton, Stark Co. Don M. Brown. Tuscarawas Co. L. E. Hicks and Edward S. Thomas.
460. *Homalocenchrus virginicus* (Willd.) Britt. Virginia Cut-grass. Hocking Co. Don M. Brown.
461. *Homalocenchrus oryzoides* (L.) Poll. Rice Cut-grass. Wood Co. R. E. Shanks. Ross Co. Gordon S. Crowl.
463. *Zizania aquatica* L. Wild Rice. Lawrence Twp., Stark Co. Don M. Brown.
467. *Panicum dichotomiflorum* Mx. Spreading Panic-grass. Pike Co. Gordon S. Crowl. Stark Co. Don M. Brown.
471. *Panicum capillare* L. Tumble Panic-grass. Ross Co. Gordon S. Crowl.
483. *Panicum polyanthes* Schultes. Many-flowered Panic-grass. Jefferson Twp., Clinton Co. E. E. Terrell, Jr.
485. *Panicum microcarpon* Muhl. Small-fruited Panic-grass. Vernon Twp., Clinton Co. E. E. Terrell, Jr.
497. *Panicum latifolium* L. Broad-leaf Panic-grass. Yok Farm, Stark Co. Don M. Brown.
506. *Paspalum circulare* Nash. Round-fruited Paspalum. Vernon Twp., Clinton Co. E. E. Terrell, Jr.
514. *Holcus halapensis* L. Johnson-grass. Vernon Twp., Clinton Co. E. E. Terrell, Jr.
527. *Lilium canadense* L. Canadian Lily. Gallia Co. Clyde H. Jones.
527.1. *Lilium michiganense* Farwell. Michigan Lily. Marion Co. Clyde H. Jones.
530. *Erythronium americanum* Ker. Yellow Dog-tooth Lily. Perry Co. Floyd and Elizabeth Clum.
538. *Allium canadense* L. Meadow Garlic. Morral, Marion Co. Don M. Brown. Oxford, Butler Co. Clarence F. Clark.

541. *Quamasia hyacinthina* (Raf.) Britt. Wild Hyacinth. Rushcreek Twp., Fairfield Co. Charles R. Goslin.
556. *Trillium erectum* L. Ill-scented Trillium. Monroe Co. Clyde H. Jones.
557. *Trillium cernuum* L. Nodding Trillium. Butler Co. Clarence F. Clark.
563. *Uvularia sessilifolia* L. Sessile-leaf Bellwort. Portage Co. Clyde H. Jones.
569. *Polygonatum commutatum* (R. & S.) Dietr. Smooth Solomon's-seal. Oxford, Butler Co. Clarence F. Clark.
571. *Vagnera racemosa* (L.) Mor. Panicled Solomon's-seal. Monroe Co. Clyde H. Jones.
572. *Vagnera stellata* (L.) Mor. Stellate Solomon's-seal. Richland Twp., Clinton Co. E. E. Terrell, Jr.
574. *Unifolium canadense* (Desf.) Greene. False Lily-of-the-valley. Portage Co. Clyde H. Jones.
578. *Asparagus officinalis* L. Asparagus. Oxford, Butler Co. Clarence F. Clark.
587. *Tradescantia reflexa* Raf. Reflexed Spiderwort. Jasper Twp., Fayette Co. E. E. Terrell, Jr.
606. *Juncus brachycarpus* Engelm. Short-fruited Rush. Vernon Twp., Clinton Co. E. E. Terrell, Jr.
608. *Juncus acuminatus* Mx. Sharp-fruited Rush. Jefferson Twp., Clinton Co. E. E. Terrell, Jr.
620. *Dioscorea villosa* L. Wild Yam. Marion Co. Clyde H. Jones.
661. *Limodorum tuberosum* L. Limodorum. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.
664. *Pogonia ophioglossoides* (L.) Ker. Rose Pogonia. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.
671. *Corallorrhiza corallorrhiza* (L.) Karst. Early Coral-root. Franklin Co. Jane Roller.
680. *Asimina triloba* (L.) Dunal. Papaw. Thorn Twp., Perry Co. Floyd and Elizabeth Clum. Butler Co. Clarence F. Clark.
685. *Ranunculus pennsylvanicus* L. f. Bristly Buttercup. Canal Fulton, Stark Co. Don M. Brown.
690. *Ranunculus hispidus* Mx. Hispid Buttercup. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.
706. *Delphinium tricorne* Mx. Dwarf Larkspur. Chester Twp., Clinton Co. E. E. Terrell, Jr. Monroe and Belmont Co. Clyde H. Jones.
713. *Anemone quinquefolia* L. Wind-flower. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.
719. *Caltha palustris* L. Marsh-marigold. Adams Twp., Clinton Co. E. E. Terrell, Jr.
720. *Hydrastis canadensis* L. Golden-seal. Wood's Cottage, Stark Co. Don M. Brown.
737. *Podophyllum peltatum* L. May-apple. Athens, Athens Co. Warren Abbott. Clinton Twp., Wayne Co. E. P. MacArthur.
746. *Papaver dubium* L. Corn Poppy. Marion Co. Don M. Brown.
751. *Macleya cordata* (Willd.) R. Br. Plume-poppy. Franklin Co. L. E. Hicks. Cultivated.
752. *Stylophorum diphyllum* (Mx.) Nutt. Yellow Celandine-poppy. Pike Co. Gordon S. Crowl.
754. *Bicuculla cucullaria* (L.) Millsp. Dutchman's-breeches. Pike Co. Gordon S. Crowl. Marion Twp., Hocking Co. Charles R. Goslin.
759. *Capnoides flavulum* (Raf.) Ktz. Pale Corydalis. Adams Twp., Clinton Co. E. E. Terrell, Jr.
765. *Draba verna* L. Vernal Whitlow-grass. Pike Co. Gordon S. Crowl. Athens Co. Warren Abbott. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.
766. *Draba cuneifolia* Nutt. Wedge-leaf Whitlow-grass. Pike Co. Floyd Bartley.
770. *Camelina microcarpa* Andrz. Small-fruited False-flax. Jasper Twp., Fayette Co. E. E. Terrell, Jr. Franklin Co. Don M. Brown.
771. *Bursa bursa-pastoris* (L.) Britt. Shepherd's-purse. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.
773. *Armoracia armoracia* (L.) Britt. Horseradish. Tillerman Bog, Greenville, Darke Co. Dale W. Jenkins.
777. *Radicula palustris* (L.) Moench. Marsh Yellow-cress. Wood Co. R. E. Shanks. Morral, Marion Co. Don M. Brown.
778. *Radicula sylvestris* (L.) Druce. Creeping Yellow-cress. Clinton Co. E. E. Terrell, Jr. Canal Fulton, Stark Co. Don M. Brown.
786. *Thlaspi arvense* L. Field Penny-cress. Tillerman Bog, Greenville, Darke Co. Dale W. Jenkins.
789. *Alliaria alliaria* Britt. Garlic-mustard. Clinton Co. E. E. Terrell, Jr. Painesville, Lake Co. Fred J. Tyler and H. C. Beardsley.
790. *Sophia pinnata* (Walt.) Howell. Pinnate Tansy-mustard. Jasper Twp., Fayette Co. E. E. Terrell, Jr.
797. *Norta altissima* (L.) Britt. Tall Hedge-mustard. Morral, Marion Co. Don M. Brown.

802. *Barbarea barbarea* (L.) MacM. Yellow Winter-cress. Athens, Athens Co. Warren Abbott.

803. *Barbarea stricta* Andrz. Erect Winter-cress. Butler Co. Clarence F. Clark. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.

805. *Iodanthus pinnatifidus* (Mx.) Steud. Purple Rocket. Ross Co. Gordon S. Crowl.

810. *Arabis laevigata* (Muhl.) Poir. Smooth Rock-grass. Ross Co. Gordon S. Crowl.

828. *Dentaria multifida* Muhl. Multifid Toothwort. Bishopville, Morgan Co. Betty Williams via Walter P. Porter.

845. *Cleome spinosa* L. Spider-flower. Greenfield Twp., Fairfield Co. R. J. Goslin and J. L. Goslin.

868. *Linum virginianum* L. Virginia Flax. Perry, Lake Co. Fred J. Tyler.

873. *Impatiens biflora* Walt. Spotted Touch-me-not. Cecil, Paulding Co. Clarence F. Clark.

882. *Polygala viridescens* L. Purple Milkwort. Jefferson Twp., Clinton Co. E. E. Terrell, Jr.

902. *Tithymalus commutatus* (Engelm.) Kl. & Garcke. Tinted Spurge. Ash Cave, Hocking Co. Jane Roller.

936. *Hypericum ascyron* L. Great St. John's-wort. Canal Fulton, Stark Co. Don M. Brown.

948. *Hypericum drummondii* (Grev. & Hook.) T. & G. Drummond's St. John's-wort. Jefferson Twp., Clinton Co. E. E. Terrell, Jr.

963. *Viola canadensis* L. Canada Violet. Monroe Co. Clyde H. Jones.

964. *Viola eriocarpa* Schw. Smooth Yellow Violet. Wood's Cottage, Stark Co. Don M. Brown.

966. *Viola hastata* Mx. Halberd-leaf Yellow Violet. Canal Fulton, Stark Co. Don M. Brown.

967. *Viola striata* Ait. Striped Violet. Canton, Stark Co. Don M. Brown.

971. *Viola rafinesquii* Greene. Wild Pansy. Wayne Twp., Warren Co. E. E. Terrell, Jr.

981. *Viola sororia* Willd. Wooly Blue Violet. Adams Twp., Clinton Co. E. E. Terrell, Jr.

1004. *Alsine graminea* (L.) Britt. Lesser Stitchwort. Canton, Stark Co. Don M. Brown.

1015. *Lychnis alba* Mill. White Lychnis. Newton, Hamilton Co. E. E. Terrell, Jr.

1025. *Silene regia* Sims. Royal Catchfly. Urbana, Salem, Twp., Champaign Co. Jane Roller.

1038. *Claytonia virginica* L. Spring-beauty. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.

1060. *Chenopodium album* L. Lamb's-quarter. Hocking Twp., Fairfield Co. Charles R. Goslin.

1063. *Chenopodium vulvaria* L. Fetid Goosefoot. Franklin Co. Robert Kavanagh. Introduced.

1080. *Steironema ciliatum* (L.) Raf. Fringed Yellow Loosestrife. Marion Co. Clyde H. Jones.

1104. *Tiniaria convolvulus* (L.) Webb. & Moq. Black Bindweed. Ross Co. Floyd Bartley.

1106. *Tiniaria dumetorum* (L.) Opiz. Copse False Buckwheat. Sippo Lake, Stark Co. Don M. Brown.

1118. *Persicaria muhlenbergii* (Wats.) Small. Swamp Persicaria. Liberty Twp., Clinton Co. E. E. Terrell, Jr.

1130. *Geum virginianum* L. Rough Avens. Marion Co. Clyde H. Jones.

1135. *Potentilla monspeliensis* L. Rough Cinquefoil. Y. W. C. A. Camp, Lake Co. Don M. Brown.

1136. *Potentilla recta* L. Upright Cinquefoil. Newton, Hamilton Co. E. E. Terrell, Jr.

1145. *Fragaria virginiana* Duch. Virginia Strawberry. Oxford, Butler Co. Clarence F. Clark.

1165. *Spiraea alba* Du Roi. Narrow-leaf Spiraea. Marion Co. Clyde H. Jones.

1205. *Aronia melanocarpa* (Mx.) Britt. Black Chokeberry. Clinton Twp., Wayne Co. E. P. MacArthur.

1207. *Amelanchier sanguinea* (Pursh.) DC. Roundleaf Juneberry. Lucas Co. Edward S. Thomas.

1208. *Crataegus crus-galli* L. Cockspur Hawthorn. Berne Twp., Fairfield Co. William Goslin.

1212. *Crataegus calpodendron* (Ehrh.) Medic. Pear Hawthorn. Geauga Co. Harry Crofoot and Fred J. Tyler.

1217. *Crataegus straminea* Beadle. Allegheny Hawthorn. Deercreek Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

1217.1. *Crataegus brumalis* Ashe. Geauga Co. Harry Crofoot and Fred J. Tyler.

1219.1. *Crataegus populnea* Ashe. Gruber's Hawthorn. Lake and Ashtabula Co. Fred J. Tyler.

1222. *Crataegus pruinosa* (Wendl.) Koch. Waxy-fruited Hawthorn. Portage Co. Harry Crofoot and Fred J. Tyler.

1228.1. *Crataegus milleri* Sarg. Miller's Hawthorn. Ashtabula, Lake Co. Fred J. Tyler and Harry Crofoot.

1228.3. *Crataegus kellermannii* Sarg. Kellerman's Hawthorn. Lake Co. Harry Crofoot and Fred J. Tyler.

1228.4. *Crataegus delecta* Sarg. Franklin Co. Fred J. Tyler.

1228.5. *Crataegus latisepala* Ashe. Lake Co. Fred J. Tyler.

1231. *Cercis canadensis* L. Redbud. Fairfield Co. William Goslin.

1232. *Gleditsia triacanthos* L. Honey-locust. Fairfield Co. William Goslin.

1234. *Cassia marilandica* L. Wild Senna. Canal Fulton, Stark Co. Don M. Brown.

1239. *Cassia leucantha* T. & G. Large White Wild-indigo. Marion Co. Clyde H. Jones.

1240. *Baptisia tinctoria* (L.) R. Br. Yellow Wild-indigo. Henry Co. R. E. Shanks.

1246. *Medicago lupulina* L. Hop Medic. Add for Fairfield, Hocking, Jackson, and Lake Co.

1248. *Trifolium agrarium* L. Yellow Hop Clover. Ross Co. Don M. Brown. Remove records for Morgan and Sandusky Co.

1249. *Trifolium procumbens* L. Low Hop Clover. Union Twp., Logan Co. A. G. Welshimer. Add for Morgan Co. Remove records for Van Wert, Lucas, and Geauga Co.

1250. *Trifolium dubium* Sibth. Least Hop Clover. Hocking Twp., Fairfield Co. Charles R. Goslin. Add for Coshocton, Hocking, and Jackson Co.

1261 *Cracca virginiana* L. Virginia Goat's-rue. Wood Co. R. E. Shanks.

1262. *Robinia pseudo-acacia* L. Common Locust. Fairfield Co. William Goslin.

1264. *Robinia hispida* L. Rose Acacia. Laurel Twp., Hocking Co. Charles R. Goslin.

1269. *Psoralea onobrychis* Nutt. Sainfoin Psoralea. Marion Co Clyde H. Jones.

1273 *Meibomia canescens* (L.) Kuntze. Hoary Tick-trefoil. Wood Co. R. E. Shanks. Pike Co. Gordon S. Crowl.

1274. *Meibomia bracteosa* (Mx.) Ktz. Large-bracted Tick-trefoil. Adams Co. A. R. Harper, Gordon S. Crowl, and Edward S. Thomas.

1276. *Meibomia michauxii* Vail. Prostrate Tick-trefoil. Pike and Ross Co. Gordon S. Crowl. Harrison Twp., Henry Co. R. E. Shanks.

1280. *Meibomia canadensis* (L.) Ktz. Canadian Tick-trefoil. Canal Fulton, Stark Co. Don M. Brown. Fairfield Co. Charles R. Goslin.

1301. *Vicia villosa* Roth. Winter Vetch. Ripley, Brown Co. E. E. Terrell, Jr.

1313. *Lathyrus tuberosus* L. Tuber-bearing Pea. Highland Co. K. A. Shutts via C. J. Willard.

1335. *Tiarella cordifolia* L. False Miterwort. Portage Co. Clyde H. Jones.

1346. *Lythrum alatum* Pursh. Wing-angled Loosestrife. Scioto Co. Charles B. Wing.

1367. *Euonymus atropurpureus* Jacq. Wahoo. Belmont Co. Clyde H. Jones.

1370. *Euonymus obovatus* Nutt. Running Strawberry-bush. Oxford, Butler Co. Clarence F. Clark.

1379. *Aesculus glabra* Willd. Ohio Buckeye. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.

1382.1 *Acer ginnala* Maxim. Ginnala's Maple. Lake Co. Harry Crofoot and Fred J. Tyler. Escaped.

1338. *Mitella diphylla* L. Two-leaf Bishop's-cap. Portage Co. Clyde H. Jones.

1410. *Urticastrum divaricatum* (L.) Ktz. Wood-nettle. New Franklin, Stark Co. Don M. Brown.

1431. *Quercus coccinea* Wang. Scarlet Oak. Geauga, Cuyahoga, and Henry Co. Ralph M. Kriebel.

1431.1. *Quercus ellipsoidalis* E. J. Hill. Hill's Oak. Lucas, Henry, and Fulton Co. Ralph M. Kriebel.

1431.2. *Quercus coccinea* Muench. var. *tuberculata* Sarg. Lucas Co. Ralph M. Kriebel. This variety was first reported for Ohio from Rush Twp., Scioto County by Conrad Roth in 1942, but due to an error in numbering appeared in the 1942 "Additions" as No. 1431.1.

1432. *Quercus borealis* var. *maxima* (Marsh.) Ashe. Northern Red Oak. Lucas Co. Ralph M. Kriebel.

1432.3. *Quercus shumardii* Buckley. Shumard's Oak. Ottawa, Lorain, and Lucas Co. Ralph M. Kriebel.

1432.4. *Quercus shumardii* var. *schneckii* (Britt.) Sarg. Schenck's Oak. Ottawa and Lorain Co. Ralph M. Kriebel.

1501.1. *Epilobium hirsutum* L. Great Hairy Willow-herb. Perry, Lake Co. Harry Crofoot.

1512. *Kneiffia fruticosa* (L.) Raim. Common Sundrops. Morral, Marion Co. Don M. Brown.

1558. *Polycodium stamineum* (L.) Greene. Deerberry. Pike Co. Gordon S. Crowl.

1559. *Vaccinium corymbosum* L. Tall Blueberry. Stark Co. Don M. Brown.

1561. *Vaccinium vacillans* Kalm. Low Blueberry. Henry Co. R. E. Shanks.

1565. *Oxycoccus macrocarpus* (Ait.) Pursh. Large Cranberry. Ashland Co. Edward S. Thomas.

1568. *Diospyros virginiana* L. Persimmon. Lawrence Co. M. T. Vermillion. Franklin Co. L. E. Hicks.

1571. *Polemonium reptans* L. Greek Valerian. Athens, Athens Co. Warren Abbott. Laurel Twp., Hocking Co. Charles Goslin. Butler Co. Clarence F. Clark.

1578. *Phlox pilosa* L. Downy Phlox. Holmes Co. E. P. MacArthur.

1579. *Phlox divaricata* L. Wild Blue Phlox. Holmes Co. E. P. MacArthur. Pike Co. Gordon S. Crowl. Athens, Athens Co. Warren Abbott. Perry Co. Floyd and Elizabeth Clum.

1582. *Phlox subulata* var. *ciliata* Wherry. Northern Ground Phlox. Holmes Co. E. P. MacArthur.

1582a. *Phlox subulata* var. *australis* Wherry. Southern Ground Phlox. York Twp., Athens Co. Warren Abbott.

1583. *Ipomoea purpurea* (L.) Lam. Common Morning-glory. Fairfield Co. William Goslin.

1584. *Ipomoea hederacea* Jacq. Ivy-leaf Morning-glory. Fayette Co. Fred H. Norris.

1588. *Convolvulus arvensis* L. Field Bindweed. Salem Twp., Meigs Co. Clyde H. Jones.

1590. *Convolvulus sepium* L. Hedge Bindweed. Clay Twp., Perry Co. Charles Reutinger. New Franklin, Stark Co. and Y. W. C. A. Camp, Lake Co. D. M. Brown.

1592. *Convolvulus fraterniflorus* Mack. & Bush. Short-stalked Bindweed. Pike Co. Gordon S. Crowl.

1597. *Cuscuta polygonorum* Engelm. Smartweed Dodder. Berne Twp., Fairfield Co. Charles R. Goslin. Belmont Co. Emma E. Laughlin.

1601. *Cuscuta gronovii* Willd. Gronovius' Dodder. Canal Fulton, Stark Co. Don M Brown.

1614. *Chionanthus virginica* L. Fringe-tree. Adams Co. A. R. Harper.

1618. *Fraxinus lanceolata* Borck. Green Ash. Marion Co Clyde H. Jones.

1636. *Apocynum androsaemifolium* L. Spreading Dogbane. Salem Twp., Champaign Co. Jane Roller.

1653. *Asclepias quadrifolia* Jacq. Fourleaf Milkweed. Vernon Twp., Clinton Co. E. E. Terrell, Jr.

1669. *Physalis virginiana* Mill. Virginia Ground-cherry. Canal Fulton, Stark Co. Don M. Brown. Salem Twp., Champaign Co. Jane Roller.

1693. *Chelone montana* var. *elatior* (Raf.) P. & W. Mountain Turtle-head. Pike Co. Floyd Bartley.

1696. *Collinsia verna* Nutt. Blue-eyed-Mary. Monroe Co. Clyde H. Jones.

1699. *Leucospora multifida* (Mx.) Penn. Leucospora. Vernon Twp., Clinton Co. E. E. Terrell, Jr.

1719. *Veronica chamaedrys* L. Bird's-eye Speedwell. Ink Park, Canton, Stark Co. Don M. Brown.

1726. *Veronica serpyllifolia* L. Thyme-leaf Speedwell. Wood's Cottage, Stark Co. Don M. Brown.

1788. *Verbena hastata* L. Blue Vervain. Marion Co. Clyde H. Jones.

1793. *Lippia lanceolata* Mx. Frog-fruit. Canal Fulton, Stark Co. Don M. Brown.

1798. *Teucrium canadense* L. American Germander. Salem Twp., Campaign Co. Jane Roller. Canal Fulton, Stark Co. Don M. Brown.

1803. *Scutellaria incana* Muhl. Downy Skullcap. Vernon Twp., Clinton Co. E. E. Terrell, Jr.

1807. *Scutellaria parvula* Mx. Small Skullcap. Union Twp., Clinton Co. and Jasper Twp., Fayette Co. E. E. Terrell, Jr.

1812. *Mentha spicata* L. Spearmint. Carroll Co. Don M. Brown.

1836. *Clinopodium vulgare* L. Field Basil. Wood's Cottage, Stark Co. Don M. Brown.

1846. *Glecoma hederacea* L. Ground-ivy. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.

1851. *Stachys palustris* L. Marsh Hedge-nettle. Salem Twp., Champaign Co. Jane Roller.

1853. *Stachys aspera* Mx. Rough Hedge-nettle. Lawrence Twp., Stark Co. Don M. Brown.

1859. *Lamium purpureum* L. Red Henbit. Adams Twp., Clinton Co. E. E. Terrell, Jr.

1860. *Lamium maculatum* L. Spotted Henbit. Allen Co. Franz Illing.

1867. *Monarda fistulosa* L. Wild Bergamot. Y. M. C. A. Camp, Lake Co. Don M. Brown.

1879. *Plantago cordata* Lam. Heartleaf Plantain. Crane Twp., Wyandot Co. Marguerite Lowery.

1902. *Deringa canadensis* (L.) Ktz. Honewort. Pike Co. Gordon S. Crowl. New Franklin, Stark Co. Don M. Brown.

1950. *Houstonia angustifolia* Mx. Narrow-leaf Houstonia. Adams Co. E. E. Terrell, Jr.

1952. *Mitchella repens* L. Partridge-berry. Mohican Forest, Ashland Co. James Stevenson. Richland Twp., Holmes Co. E. P. MacArthur.

1957. *Galium pilosum* Ait. Hairy Bedstraw. Y. M. C. A. Camp, Lake Co. Don M. Brown.

1982. *Viburnum prunifolium* L. Black Haw. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.

1986. *Triosteum perfoliatum* L. Common Horse-gentian. Greenfield Twp., Fairfield Co. Charles R. Goslin.

1997. *Lonicera glaucescens* Rydb. Glaucesent Honeysuckle. Ashtabula Co. Harry Crofoot.

1999. *Lonicera sullivantii* Gr. Sullivant's Honeysuckle. Salem Twp., Champaign Co. Jane Roller.

2019. *Lobelia inflata* L. Indian-tobacco. Ross Co. Gordon S. Crowl.

2021. *Lobelia spicata* L. Pale Spiked Lobelia. Geauga Co. E. P. MacArthur.

2024. *Xanthium pennsylvanicum* Wallr. Pennsylvania Cocklebur. Hocking and Fairfield Co. Charles R. Goslin.

2029. *Ambrosia elatior* L. Roman Ragweed. Berne Twp., Fairfield Co. William and Robert Goslin.

2033. *Rudbeckia hirta* L. Black-eyed Susan. Vinton Co. A. G. Welshimer.

2036. *Rudbeckia sullivanti* Boynt. and Bead. Sullivant's Cone-flower. Adams Co. Edward S. Thomas.

2045. *Helianthus giganteus* L. Giant Sunflower. Highland Co. Katie M. Roads.

2055. *Helianthus decapetalus* L. Thinleaf Sunflower. Ross Co. Gordon S. Crowl.

2057. *Helianthus strumosus* L. Paleleaf Wood Sunflower. Highland Co. Katie M. Roads.

2060. *Helianthus hirsutus* Raf. Hirsute Sunflower. Highland Co. Katie M. Roads.

2071. *Bidens comosa* (Gray) Wieg. Leafy-bracted Bur-marigold. Clinton Co. E. E. Terrell, Jr. Fairfield Co. Charles R. Goslin.

2077. *Bidens vulgata* Greene. Tall Beggar Ticks. Athens, Athens Co. Warren Abbott.

2079. *Bidens frondosa* L. Black Beggar-ticks. Franklin Co. A. R. Harper and Edward S. Thomas.

2080. *Bidens bipinnata* L. Spanish-needles. Laurel Twp., Hocking Co. Charles R. Goslin. Ross Co. Gordon S. Crowl.

2088. *Polymnia canadensis* L. Small-flowered Leaf-cup. Portage Co. Don M. Brown.

2092. *Silphium perfoliatum* L. Indian-cup. Wood Co. R. E. Shanks.

2093. *Silphium trifoliatum* L. Whorled Rosin-weed. Marion Co. Clyde H. Jones.

2097. *Helenium nudiflorum* Nutt. Purple-headed Sneezeweed. Fairfield Co. E. E. Terrell, Jr. Gallia Co. Clyde H. Jones.

2103. *Inula helenium* L. Elecampane. Stark Co. Don M. Brown.

2110. *Anaphalis margaritaceae* (L.) Gray. Pearly Everlasting. Athens, Athens Co. Warren Abbott.

2112. *Antennaria plantaginifolia* (L.) Rich. Plantain-leaf Everlasting. Holmes Co. E. P. MacArthur.

2114. *Antennaria neodioica* Greene. Smaller Everlasting. Pike Co. Gordon S. Crowl.

2116.2. *Grindellia lanceolata* Nutt. Narrow-leaf Gum-plant. Vore Ridge, Athens Co. Walter P. Porter and P. S. Wamsley.

2121. *Solidago hispida* Muhl. Hairy Goldenrod. Pike Co. Gordon S. Crowl.

2123. *Solidago caesia* L. Wreath Goldenrod. Laurel Twp., Hocking Co. Charles R. Goslin. Pike Co. Gordon S. Crowl.

2130. *Solidago canadensis* L. Canada Goldenrod. Highland Co. Katie M. Roads.

2134. *Solidago ulmifolia* Muhl. Elmleaf Goldenrod. Odell Creek Sanctuary, Friendship, Scioto Co. R. B. Gordon, J. S. Katz, and F. B. Chapman.

2137. *Solidago juncea* Ait. Plume Goldenrod. Fairfield Co. Charles R. Goslin. Buckeye Lake, Licking Co. Warren Abbott. Ross Co. Gordon S. Crowl.

2145. *Sericocarpus asteroides* (L.) B. S. P. Toothed White-top Aster. Adams Co. E. E. Terrell, Jr.

2148. *Aster schreberi* Nees. Schreber's Aster. Ross Co. Gordon S. Crowl.

2149. *Aster macrophyllus* L. Largeleaf Aster. Pike Co. Gordon S. Crowl.

2154. *Aster lindleyanus* T. & G. Lindley's Aster. Athens, Athens Co. Warren Abbott.

2155. *Aster sagittifolius* Willd. Arrowleaf Aster. Stark Co. Don M. Brown.

2157. *Aster undulatus* L. Wavy-leaf Aster. Adams Co. Fred H. Norris.

2158. *Aster puniceus* L. Purple-stem Aster. Green Twp., Ross Co. Floyd Bartley.

2160. *Aster novae-angliae* L. New England Aster. Logan Co. A. G. Welshimer. Clinton Co. E. E. Terrell, Jr.

2180. *Erigeron ramosus* (Walt.) B. S. P. Daisy Fleabane. Yok Farm, Stark Co. Don M. Brown.

2186. *Ionactis linariifolius* Greene. Stiffleaf Aster. Madison Twp., Fairfield Co. Gene and Helen Rea.

2188. *Eupatorium purpureum* L. Purple Joe-Pye-Weed. Vernon Twp., Clinton Co. E. E. Terrell, Jr.

2231. *Senecio aureus* L. Golden Squaw-weed. Ashland Co. Clyde H. Jones.

2250. *Cirsium odoratum* (Muhl.) Britt. Fragrant Thistle. New Franklin, Stark Co. Don M. Brown.

2259. *Centaurea maculosa* Lam. Spotted Star-thistle. Green Twp., Clinton Co. E. E. Terrell, Jr.

2270. *Apargia autumnale* (L.) Hoffm. Fall Hawkbit. Franklin Co. Clyde H. Jones.

2277. *Hieracium gronovii* L. Gronovius' Hawkweed. Jefferson Twp., Clinton Co. E. E. Terrell, Jr.

2284. *Hieracium venosum* L. Veined Hawkweed. Vernon Twp., Clinton Co. E. E. Terrell, Jr.

2309. *Leontodon taraxacum* L. Dandelion. Thorn Twp., Perry Co. Floyd and Elizabeth Clum.

DESCRIPTIONS OF THE NEOTYPE OF DRAECULACEPHALA MOLLIPES (SAY) AND A NEW SPECIES PREVIOUSLY CONFUSED WITH IT

(HOMOPTERA, CICADELLIDAE)

RALPH H. DAVIDSON AND DWIGHT M. DELONG,
Department of Zoology and Entomology,
The Ohio State University

For many years the green and yellow sharp-headed leafhopper, *Draeculacephala mollipes* (Say), has been recognized as one of our common and abundant grass-feeding species in pastures, meadows and on certain of the cultivated grass crops. Recent studies of the genital structures of the males of this group have shown that a second common species described and illustrated herewith as *constricta* has been confused with *mollipes* because of their superficial resemblance. In view of the fact that the type specimens of *mollipes* have been destroyed, it has been necessary to designate which of these species should bear the name *mollipes*. The original description of *mollipes* would fit either species so we have agreed on the designation of the specimens described and illustrated at this time as *mollipes* (Say). We arrived at this decision after careful study of the male genital characters of large series of specimens previously identified as this species. A neotype is, therefore, being erected to serve as a future type for the species. A taxonomic revision of the entire genus has been completed and has been submitted for publication.

Draeculacephala mollipes (Say)

Tettigonia mollipes Say, Jour. Acad. Nat. Sci. of Phila. 6 : 312, 1831.

A yellow and green species with acutely angled vertex and without distinct markings. Length male 6 mm., female 7.5–8 mm.

Vertex produced, apex blunt, as long as or slightly longer than basal width and slightly longer than pronotum.

Color: Vertex, anterior portion of pronotum and scutellum yellow, posterior portion of pronotum and elytra dark green. Vertex faintly marked with narrow brownish lines.

Genitalia: Female last ventral segment with posterior margin concavely roundedly produced either side of a median produced rounded apex. Male plates long, concavely tapered to narrow, rounded divergent apices. Styles short, rather broad at middle, apical portion bent inwardly, and outer margin concavely rounded to pointed apex. The ventro-anterior portion of aedeagus with a pair of rather short, thick, dorsally directed processes and a pair of long, spine-like ventral processes which diverge and extend caudally to tip of aedeagus with their apices curved dorsally. Dorso-posterior portion with a pair of dorsally directed divergent processes and a ventral process which in ventral view appears elongate, about one-third as wide as long with narrow base and narrow bluntly pointed apex.

A male specimen from Hocking County, Ohio, collected August 25, 1935, by Dr. J. S. Caldwell, is designated as the neotype and a female from the same locality as the neallotype. Male and female specimens in the series are designated paratypes. All types deposited in the authors' collections.

Data from labelled specimens authentically identified as this species indicates the following distribution by states: Maine, New York, Pennsylvania, Ohio, Indiana, Illinois, Tennessee, Missouri, Wisconsin, Minnesota and Ontario, Canada.

Draeculacephala constricta n. sp.

Resembling *mollipes* in size, form and color but with distinct male genitalia. Length male 6.5 mm., female 8 mm.

Vertex produced and bluntly angled, in both sexes as long as basal width and slightly shorter than pronotum.

Color: Vertex, anterior portion of pronotum and scutellum yellow, vertex marked with faint brownish longitudinal lines. Posterior portion of pronotum and elytra dark green, veins paler.

Genitalia: Female last ventral segment produced from lateral angles, concave either side of median produced apex which is bluntly pointed. Male plates long, reaching to tips of pygofers, concavely narrowed to acute rounded apices. Styles short, broad at middle, apical portion bent inwardly, narrowed to pointed apices. Ventro-anterior portion of aedeagus with a pair of dorsally directed basal processes and a ventral pair of posteriorly directed divergent spine-like structures which extend almost to end of aedeagus and have apices which bend upward. Dorso-posterior portion with a pair of dorsally directed processes and a ventral portion which is elongate, narrowed at base, convexly rounded to almost one-half its width and with apex broadly rounded. In lateral view it is decidedly constricted just before base.

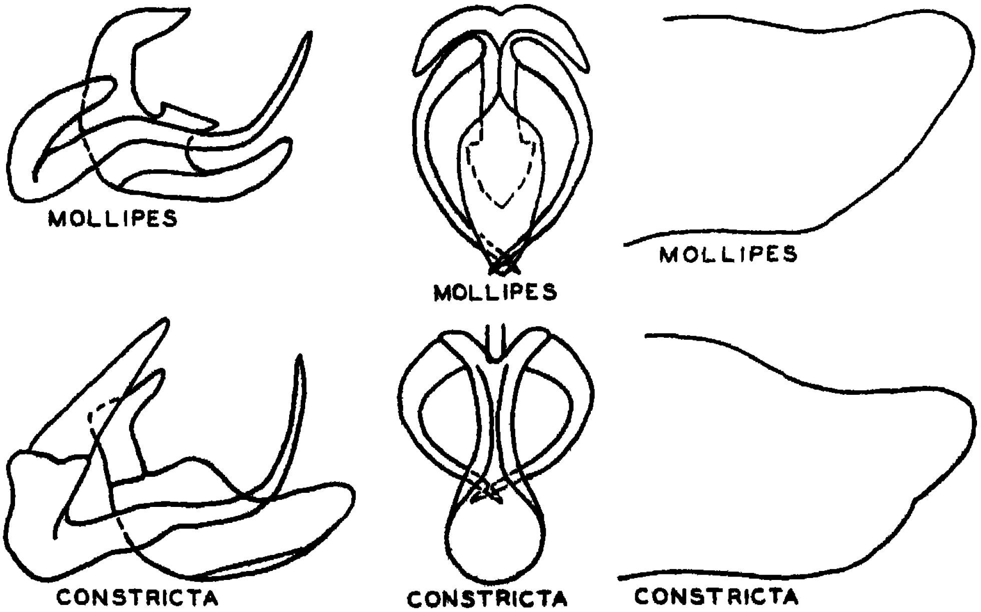


FIG. 1. Lateral and ventral views of the aedeagi, and lateral views of the pygofers.

Holotype male, allotype female and male and female paratypes from Washington County, Ohio, Oct. 12, 1940, collected by the senior author and deposited in the authors' collections. Male and female paratypes from Vandalia, Ohio, June 10, 1934 (Davidson); Northeast, Penn., June 15, 1917 (DeLong) in the Ohio State University collection. A large series of male and female paratypes collected at a light in Athens, Ohio, June 2, 1934 (W. C. Stehr) and deposited in the University of Minnesota collection. A large series of male and female paratypes deposited in the Illinois Natural History Survey collection are from the following localities in Illinois: St. Joseph, Fulton, Pike, Alton, Springfield, Princeton, Oquawka, Loda, Monmouth, Danville, Shawneetown, Havana, Pulaski, Apple River Canyon, Macomb, Anna, Oakwood, Urbana, Castle Rock, Beach, Evergreen Park, Dixon, Savannah, Wauconda, Hanover, Algonquin, Decatur, Thomson, Champaign, Zion, St. Anne, Dubois, Oak Lawn, Seymour, Kankakee, Dixon Springs, Parker, Warren, Weldon Springs, Dongola, Marshall, McHenry, Carbondale, Mt. Carmel, Metropolis, Grafton, Barry, Amboy, Vienna, Orangeville, Sheffield and Putnam.

Other areas from which this species has been taken are Maine, New York, New Jersey, Virginia, West Virginia, Kentucky, Tennessee, Indiana, Michigan, Wisconsin, Iowa, Missouri, Oklahoma, Texas, Florida, Kansas, Nebraska, South Dakota, Minnesota, Montreal, Quebec; and Banff, Alberta, Canada.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIII SEPTEMBER, 1943 No. 5

VARVES IN SANDUSKY BAY SEDIMENT

IRA T. WILSON
Heidelberg College, Tiffin, Ohio

While determining the quantity and distribution of the sediment in Sandusky Bay near the western end of Lake Erie for the Division of Conservation of Ohio, the writer found the deposits to be varved. Since several nearly complete cores of sediment were secured, an estimation of the total number of varves has been possible. Estimates of three cores have been made, two in the Bay proper and one at the edge of the Bay. This last core penetrated 10 feet of deposit that lies above the level of the Bay floor that is not represented in the other two borings. Since it represents as complete a profile as is likely to be found of the lacustrine deposits of the glacial waters that covered northwestern Ohio for a considerable part of post-glacial time, it was thought that the varve count might be of interest to glaciologists.

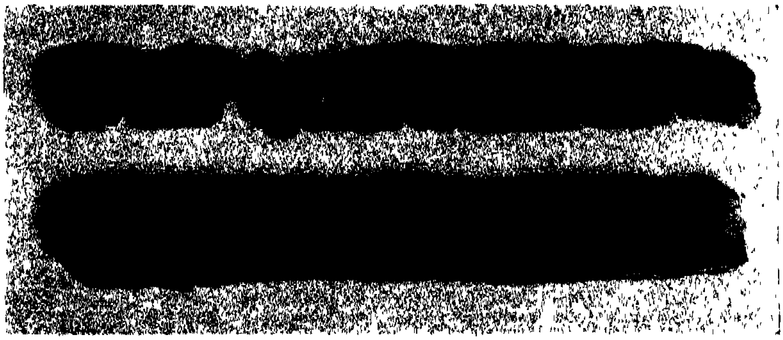


FIG. 1. A piece of core from a boring near the center of Sandusky Bay torn open thus exposing the varved structure of the deposit. After being torn open the core was allowed to dry which caused enough shrinkage to accentuate the gaps between the layers. The visible layers are only one-half of those actually present; they are the thicker winter deposit. The very thin quartz layers, between those that are visible, that make up the summer deposit do not show in the photograph.

The Bay lies inside the shorelines of the glacial lake that existed in front of the Huron-Erie lobe of the Wisconsin ice sheet. As inferred from Taylor's account (Leverett and Taylor, 1915)[1] glacial waters covered the region from the late Maumee stage, through the Arkona, Whittlesey, Wayne, Warren and Elkton stages. After the Elkton stage the melt water of the upper lake (Algonquin) found drainage eastward (Kirkfield outlet) and lowered the lake level in the Erie basin below that of the Bay region, thus ending deposition there. The present Bay is the widened mouth of the Sandusky River which cut its way through the lacustrine deposits of this series of lakes after the Elkton stage. The glacier was retreating from Sandusky Bay to a point near the Niagara gorge during the period of deposition of the sediment referred to here—a distance of approximately 250 miles.

---

[1] Leverett, Frank, and Taylor, Frank B., 1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes. United States Geological Survey. Monograph 53: 316-518.

The cores of sediment were secured by driving the sampler (¾-inch tube) into the sediment approximately one foot at a time in soft sediment and as little as two inches in hard sediment. An attempt was always made to get a sample of the same length as the distance the sampler was driven into the sediment. This procedure avoided compaction of the sediment. The sampling was carried on inside a casing that was always driven to the level of the bottom of the last sample and washed clean before a new sample was taken. This method entailed the loss of about two inches of core between each sample. Cores were torn open lengthwise to reveal the varved structure. Examination of Figure 1 reveals the varved structure of a typical sample.

The technique of estimating the total number of varves consisted first, in dividing the depth of the boring into increments and counting accurately the varves of the available sediment of each increment, and second, determining the average number of varves per inch (in the available sediment) and multiplying this by the number of inches penetrated in securing the samples included in the increment. This method gives an estimate that includes the portions of sediment lost between samples. Finally, the estimates of all the increments were added together to secure the total number of varves in the core. In choosing the increments care was taken to include as uniform thicknesses of varves as was possible, thus keeping the deviation of any of the varves from the average of its increment at a minimum.

Both the winter and summer layers of the varves in the deposits reported here are very distinct, one of them being thin, white and composed almost entirely of fine quartz crystals, whereas, the other is thicker, dark and composed mostly of clay, some carbonates and a slight amount of organic matter. The particles of the white quartz layer of the varve are so poorly cemented that the core easily breaks apart along it, but those of the dark stratum are well cemented together. Frequently the dark stratum of a varve shows eight or ten subdivisions that may represent disturbances of settling caused by individual storms.

The sizes of the particles that make up the varved deposit vary from 50% at some levels to 60% at others that are less than 2 microns in diameter. Maximum sizes (found only at the lower levels) vary from 35 to 80 microns.

Table I shows (for the most complete core—it includes 10 feet of sediment above the present Bay level) the depths limiting each increment, the average number of varves per inch, the total number of varves in each increment, and the total number of varves for all the increments, i. e., in the complete core. The total depth of sediment in this case is 37′ 7″. The sediment of this boring lies on bed rock. It can not be stated definitely that this core includes all of the deposit of the glacial lake under consideration since some may have been lost by erosion or by removal by readvancing ice. Erosion has probably been slight due to the extreme flatness of the region. The varve estimates made in the three cores gave comparable results.

An examination of the column in the table labelled "Av. per inch" shows that the varves vary in thickness somewhat at different levels. Twelve and one-half varves is the minimum number per inch and 38 the maximum. Although there are minor fluctuations from increment to increment in the number of varves, there is in general a decrease in the number per inch from the lower to the higher levels of the deposit, i.e., the varves get thicker the nearer the surface is approached.

This indicates a greater annual deposition in the higher levels. The differences in thickness of varves are due almost entirely to differences in the dark layer. Dr. George M. Stanley (personal communication) suggests that "the increasing thickness of varves towards the top of the section is largely a result of the shallowing lake and nearer shoreline, since this is probably the principal source of sediment."

TABLE I

RECORD OF THE ESTIMATES BY INCREMENTS (SELECTED BECAUSE OF THE UNIFORMITY OF THICKNESS OF THE LAYERS WITHIN IT) OF THE VARVES IN A BORING A FEW FEET BEYOND THE SOUTHERN EDGE OF SANDUSKY BAY ON LAKE ERIE. ESTIMATES ARE NECESSARY BECAUSE A FEW INCHES OF THE CORE BETWEEN EACH SAMPLE TAKEN WERE LOST. THEY WERE MADE BY DETERMINING THE AVERAGE NUMBER OF VARVES IN THE AVAILABLE SEDIMENT (USUALLY ABOUT 75%) OF EACH INCREMENT AND MULTIPLYING THIS NUMBER BY THE TOTAL NUMBER OF INCHES IN THE INCREMENT

Depth of Increments	Average Number of Varves per Inch	Number of Varves in Increments	Depth of Increments	Average Number of Varves per Inch	Number of Varves in Increments
0– 1'5"	12.5	212.5	18'–19'3"	31	465
1'5"–2'2"	16	144	19'3"–20'7"	33	528
2'2"–2'11"	21	189	20'7"–21'11"	36	540
2'11"–4'4"	18	306	21'11"–23'5"	32	576
4'4"–4'10"	17	102	23'5"–24'	29	203
4'10"–5'8"	16.5	165	24'–25'	29	348
5'8"–6'4"	22	176	25'–25'6"	28.6	171.6
6'4"–6'11"	17	119	25'6"–26'6"	30	360
6'11"–7'5"	19.5	117	26'6"–27'	33	198
7'5"–8'	16.5	115.5	27'–28'	38	494
8'–9'	19	228	28'1"–28'6"	34	170
9'–9'10"	23	230	28'6"–29'7"	33.5	435.5
9'10"–10'8"	21.5	215	29'7"–30'	36	180
10'8"–11'8"	20	240	30'–31'1"	34	442
11'8"–12'8"	27.5	330	31'1"–32'7"	28	504
12'8"–13'8"	27	314	32'7"–34'1"	28.5	513
13'8"–14'8"	32	384	34'1"–34'10"	29.5	265.5
14'8"–15'8"	32.5	390	34'10"–35'8"	29	290
15'8"–16'8"	28.6	323.2	35'8"–37'2"	30	540
16'8"–18'	34	544	37'2"–37'7"	31	155

Grand Total of Varves, 12,223

The total number of varves in the core, namely, 12,223, certainly represents the minimum number of years that the Sandusky Bay region was covered by cold glacial waters. Since the Erie lobe of the glacier receded approximately 250 miles during this time it must have receded at an average rate of 108 feet per year.

The writer is indebted to the Department of Conservation of Ohio for financial support for the field work, to Dr. T. H. Langlois, of the Franz Theodore Stone Biological Laboratory for arranging for the work and for many suggestions, to Dr. George M. Stanley, of the University of Michigan, for suggestions and criticism, to Robert Heaver and Robert Wilson for helping do the field work, and to Donald Wohlschlag and Albin Jankowitz for assisting in counting the varves and determining the proportions of various particle sizes.

STUDIES IN THE BIOLOGY OF THE LEECH.[1] VI.

THE ANATOMICAL BASIS FOR CERTAIN LEECH BEHAVIOR

JOHN A. MILLER
Department of Zoology and Entomology,
The Ohio State University, Columbus, Ohio

The behavior of an animal is the result of stimuli acting upon a particular arrangement of anatomical structures. In the leech a specific neuromuscular pattern is present. Motor neurons of this mechanism can be stimulated directly by direct current of low voltage. Miller (1934). The responses of the leech in an electrical field constitute the experimental basis upon which the probable arrangement of motor neurons enervating body wall muscles has been postulated. Miller (1936). The polarity of motor neurons is determined by the application of the "law of polar stimulation." Lillie (1923). The same technique has been successfully applied by Shensa and Barrows (1932) in their study of galvanotropic responses in the earthworm. The position and extent of the motor neurons in both the leech and the earthworm have been suggested by the resulting behavior of the organism. In every instance where the behavior of the organism involved only a few segments, it was apparent that motor neurons within the cord extended through several ganglia. In the present paper I propose certain anatomical features in support of the experimental evidence previously reported.

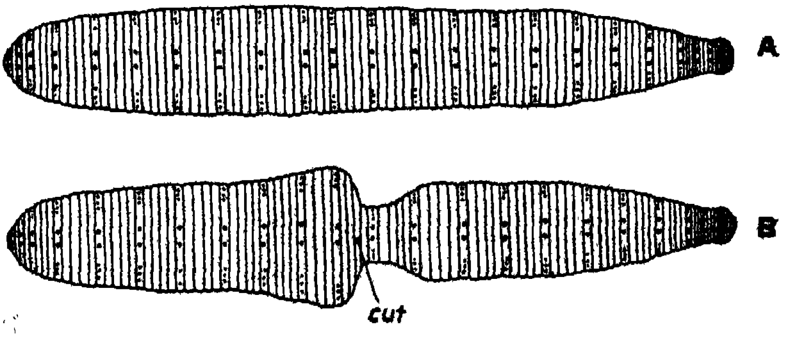


FIG. 1. A. The normal shape of the leech. B. The change in body form following nerve cord transection.

In a preceding paper of this series, Miller (1942), there was presented an account of the deviations in body form following nerve cord transection. Fig. 1. The specific reaction to which I was to refer is one occurring in the mid-body region following the transection of the ventral nerve cord. The operated leech showed in the region of the severed cord a constriction extending anteriorly, and an enlargement extending posteriorly. In the mid-body region a typical segment consists of five annuli. The affected area extended from three to five annuli anterior to the cut and from four to six annuli posterior to the cut. The area affected depended upon the relation of the cut to the segmental ganglia.

In the segment anterior to the cut, there was a loss of tone in the longitudinal muscles. Posterior to the cut there was a corresponding loss of tone in the circular

---

[1] *Haemopis marmoratis* (Say).

muscles. The minimum area affected embraces no less than two complete segments. From these observations it seemed reasonable to imply that motor neurons extended for short distances in the cord. According to Smallwood (1930) interganglionic neurons in the earthworm are small in size and few in numbers. Smallwood further states that these interganglionic nerve cells play but a small part in transmitting impulses from ganglion to ganglion. It is his contention that interganglionic correlation is the function of the giant fibers. Ogawa (1939), also

FIG. 2. Photomicrograph. A frontal section through a leech ganglion.

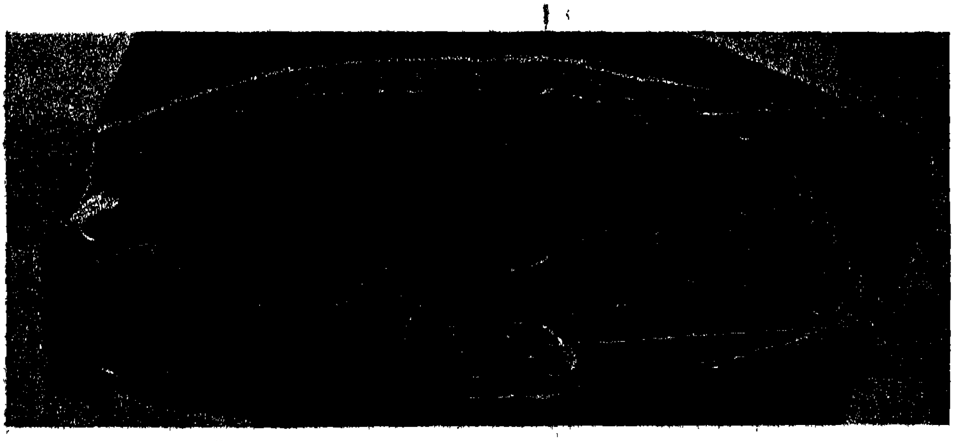


FIG. 3. Photomicrograph. A longitudinal section through a leech ganglion.

(v. n. c.) Ventral nerve cord. (n.) Interganglionic processes. (n_1) Interganglionic processes entering a lateral nerve. (n_2) Interganglionic processes continuing through the ganglion. (n_3) Motor axons entering immediate lateral nerve. (n_4) Motor axons extending into the ventral nerve cord. (m. c. b.) Motor cell bodies.

working with the earthworm, described numerous interganglionic nerve cells. Of the three types described, one which he calls "the gross cell" and which was previously mentioned by both Retzius and Krawany, is motor. This type of cell is described as passing over two or three adjacent ganglia. These are unipolar cells, the axon of which gives off numerous collaterals during its course.

In leech preparations, Figs. 2 and 3, using a special technique developed by the author, neurons similar to those described by Ogawa can be traced. In both frontal and lateral views interganglionic processes are visible. Certain of these processes enter the lateral nerves (n_1); others continue through the ganglion to adjacent segments (n_2). In passing through a ganglion, these long fibers occupy a position dorsal to the mass of nerve cell bodies. Fig. 3. In each ganglion large motor cell bodies are observed in well defined areas. Figs. 2 and 3. Several distinct types can be differentiated, among which are those whose axons enter the immediate lateral nerves (n_3), while others send their protoplasmic extensions into the nerve cord (n_4). This anatomical evidence substantiates the previous conclusions derived from experimental evidence, namely, that motor neurons extend short distances in the cord. It further offers an anatomical basis for understanding the segmental behavior following nerve cord transection.

The position of the nervous elements in the central system of the leech have, up to the present time, been determined almost entirely upon inferences drawn from experimental evidence. This is the first of a series of papers based on the neuro-anatomy of the leech and devoted to an analysis of the action systems, whereby the functional relationship of this mechanism can be applied to an understanding of the behavior of the organism.

LITERATURE CITED

Lillie, R. S. 1923. *Protoplasmic Action and Nervous Action.* Univ. of Chicago Press, pp. 1–417.

Miller, John A. 1934. Studies in the Biology of the Leech. No. II. The Ohio Jour. Sci., 34: 57–61.

1936. Studies in the Biology of the Leech. No. IV. The Ohio Jour. Sci., 34: 343–348.

1942. Studies in the Biology of the Leech. No. V. The Ohio Jour. Sci., 42: 45–52.

Ogawa, Fumiyo. 1939. The Nervous System of Earthworm (*Pheretima communissima*) in Different Ages. Sci. Reports, Tohuku Imperial Univ., 4th. series, Biol., 13: 295–488.

Shensa, L. S. and **Barrows, W. M.** 1932. The Subepidermal Nerve Plexus and Galvanotropism of the Earthworm, *Lumbrious terrestris* Linn. The Ohio Jour. Sci., 32: 507–512.

Smallwood, W. M. 1930. *The Nervous Structure of the Annelid Ganglion.* Jour. Comp. Neur., 51: 277–392.

Cytology

A highly condensed description of the equipment and procedures used in the study of both animal and plant chromosomes. Consequently the user of the book will find himself repeatedly forced to seek out other sources of information. For example, the technique of centrifuging is disposed of in two lines on page 69 by citing three publications. There are 25 pages of bibliography. The book will therefore be very useful as a subject guide to the literature. Two matters of conjecture are stated in ways that may give the incorrect impression that they are established facts: on page 18, chromosomes ". . . are amongst the largest molecules . . .;" and on page 59, in salivary gland chromosomes ". . . each gene therefore appears as a band . . ." There are 14 plates of excellent photomicrographs (although the authors insist on calling them microphotographs, pp. 77 and 89). It is unfortunate the plates were not numbered or labelled in some way so as to facilitate correlating them with their descriptions.

—*E. F. Paddock.*

The Handling of Chromosomes, by C. D. Darlington and L. F. LaCour. The Macmillan Co., New York, 1941. 165 pp., 14 pl., 7 figs. $2.50.

AN ECOLOGICAL STUDY OF THE WORM PARASITES OF PORTAGE LAKES FISHES

ROBERT C. HARE
University of Akron, Akron, Ohio

During the years of 1939 and 1940 a taxonomic and ecological study was made of the worm parasites of the fishes of the Portage Lakes, near Akron, Ohio. The complete results of this work are presented in an unpublished thesis (Hare, 1941) of which the present paper is a summary.[1]

We have attempted to bring out in this work not only the kinds of worms found in each host, but also to show the various ecological factors involved, e.g., the effect of season, habitat, age, and food relations on parasitism.

The Portage Lakes comprise a chain of small lakes and reservoirs extending southward from the city of Akron, Ohio. Summit Lake is within the city. Nesmith Lake, 41 acres, depth 10–24 feet; North Reservoir, 136 acres, depth 4–12 feet; East Reservoir, 292 acres, depth 12–25 feet; and Turkeyfoot Lake, 531 acres, depth 10–50 feet, were the principal lakes from which collections were made. The group includes also Long Lake, West Reservoir, and smaller tributary lakes as Hower's Lake from North Reservoir, Mud Lake and Rex Lake from Turkeyfoot. There is also small, shallow, weedy Grape Lake. Further to the south is the still larger, newly formed Nimisila Reservoir. A few specimens were also taken from the Ohio Canal, part of which connects Summit Lake with Nesmith Lake. The shore line of the chain offers a great variety of conditions from cottage-lined banks to large marshy areas. The lakes and fish conditions were reported on by Osburn (1921), and studies of fish food and plankton were made by Kraatz (1928, 1931, 1941).

Acknowledgment of indebtedness of the author goes to Paul Eschmeyer for collections of fish and their identification; Dr. R. V. Bangham for identification of many parasites; Fred H. Glenny for assistance in preparing slides of parasites; Samuel Caplin for photographs of parasites (not included in this paper), and Dr. Walter C. Kraatz for suggestions and help in the work and the thesis and this paper.

COLLECTIONS AND PREPARATION

Fish were caught over a period of a year by set net, seine, and hook and line from all possible ecological habitats and examined fresh immediately or after icing.

All worm parasites were removed while alive and kept for study in a 0.7% $NaHCO_3$ solution (Van Cleave and Mueller, 1934). Fish were examined singly by hand; each organ removed to separate dish of soda solution; parasites removed and freed of mucus in fresh solution.

Several killing and fixing agents were employed. Nematodes were put in hot 70% alcohol; Cestodes and Trematodes in hot Bouin's fluid, 12–24 hours, and later placed in 70% alcohol. Leeches were also fixed in Bouin's, and Acanthocephala were placed in tap water whereupon their beaks extended, and then fixed in Bouin's.

Most of the worms were stained and mounted in toto, using para-carmine or borax carmine, and cedar oil for clearing. Some fish livers were sectioned to reveal smaller parasites, staining with Ehrlich's haematoxylin and eosin.

---

[1] The thesis was in partial fulfillment of the requirements for the degree Master of Science, University of Akron, 1941. Due to the entrance of Robert C. Hare into the U. S. Army, Dr. Walter C. Kraatz collaborated in the production of this paper.

The total number of fish examined for all worm parasites was 127, or 21 species, falling in 8 families. These are listed in the course of the paper. This is somewhat less than half of all the recorded fish species of the lakes. Of the 29 species not taken, 17 are minnows, 4 catfish, and 5 sucker species.

THE PARASITES, THEIR ABUNDANCE AND DISTRIBUTION IN RELATION TO HOSTS

Parasites found belong to Trematoda, Cestoda, Nematoda, Acanthocephala and Hirudinea.

Trematoda.—Ectoparasitic Trematodes, order Monogenea, were not represented. All those found were of Order Digenea, which require a snail as host for prior larval stages. There are two possible conditions: (1) those which attain maturity in the fish (then chiefly in the digestive tract), (2) those which are immature in the fish (metacercariae) to reach functional maturity only after being eaten by a fish-eating bird or mammal—or possibly some second predator fish or other aquatic vertebrate.

Allocreadium sp.—Three specimens were found in intestine of the common sunfish from shallow water over mud bottom in the Ohio Canal.

Microphallus Ward, 1901.—*Microphallus opacus* was found only in one rock bass, taken August 1 in shallow, weedy water of the Ohio Canal. About a dozen of the worms were present in stomach and intestine. Crayfish are said to carry the metacercaria in their liver (Ward, 1894). It may be significant that the rock bass host had a large crayfish in its stomach. Four of the nine specimens in the stomach were still metacercariae.

Strigeidae—Those found were all of the larval group *Neascus*, well described by Hughes (1927). All occur in fish as encysted metacercariae.

Neascus vancleavii (Agersborg, 1926).—This parasite was found encysted in internal organs of various Centrarchidae, in moderate to heavy infestations. The common sunfish was very susceptible. The liver was infested with hundreds of the larvae. Most parasitized fish were from shallow water. The age of the fish seems to have bearing on Neascus infestation, at least in the bluegill. Of 14 of these under 4 inches from various localities in the lake, none were infested, but of the five larger bluegills, three were heavily infested. Some hybrids of common sunfish and bluegill were only lightly infested. Other hosts were the large-mouth black bass, warmouth bass.

Neascus amblŏplitis Hughes (1927).—This common parasite occurs as a deeply pigmented integumentary cyst, forming a slight elevation; often a fish appears literally peppered with them. All the infested fish were from shallow water. Heaviest infestations were found in perch, log perch, large-mouth bass; less in warmouth bass, long-eared sunfish and steel-colored minnow. Perch were seldom found without the cysts. Only young of the large-mouth bass were infested. Of ten bass under four inches from various parts of the lakes, nine were infested, whereas of nine over four inches, none were infested.

Cestoda.—Adults of fish tapeworms always occur in the alimentary canal of the fish. There is more flexibility of host species than in Trematodes, and also in host relations in larval stages. Larvae usually develop in Arthropods. In addition to serving as hosts for adult tapeworms, fishes frequently shelter advanced larvae which reach maturity in other fishes, amphibia, reptiles, birds or mammals.

Cestoda do not occur as abundantly as Trematoda or Acanthocephala in Portage Lakes fishes.

Proteocephalus, La Rue, 1914; *Proteocephalus ambloplitis* (Leidy).—This is the most common species of cestode in Portage Lakes fishes. It was found in the digestive tract of all five of the garpike examined and in the stomach of the large-mouth bass. Larval forms were found in the liver, gonads and body cavity of the garpike and bluegills and in the pericardial cavity of the bass. These larvae have been known to cause economic loss because of infestation of gonads of hatchery bass. Bangham (1927) refers to it as "a most serious handicap to the hatching of bass."

Copepods have been shown (Hunter, 1928) to serve as first host for *P. ambloplitis*. Van Cleave and Mueller (1934) state that Proteocephalus is of general distribution. Young fish seem less susceptible. All of the parasites were from mature fish.

Proteocephalus fluviatilis Bangham (1925).—Eight adults of this species were taken from one large-mouth black bass, caught May 23 in deep water in East Reservoir.

Proteocephalus singularis La Rue (1911).—This species, both as larvae and adults, occurred in the stomach of the long-nosed gar. In one instance over a hundred were taken from one host. All the fishes were from deep water.

Corallobothrium Fritsch; *Corallobothrium fimbriatum* Essex (1928).—Four worms of this species were found in the intestine of one mature black bullhead caught in January through the ice of Grape Lake.

Nematoda.—Roundworms were less frequently encountered than preceding group in Portage Lakes fishes.

Contracaecum Raillet and Henry.—The genus belongs to the Ascaroidea. *Contracaecum* sp.—Numerous larvae were encysted in the walls of the intestine and in mesenteries of two black bullheads caught January 1 through the ice of Grape Lake.

Philometra Costa.—The genus belongs to the order Filarioidea. *Philometra cylindracea* Ward and Magath (1917)—A single adult female of this roundworm was taken from the intestine of a rock bass August 1, from the shallow water of the Ohio Canal.

Acanthocephala.—Thorny-headed worms were found to be the most abundant worm parasites of fishes in this study, although only three species of these parasites were found.

Neoechinorhynchus Hamann; *Neoechinorhynchus cylindratus* (Van Cleave, 1913).—This worm occurred in great abundance in the large-mouth black bass, crowding the intestine. It was found in both young and old fish, the severity of the infestation increasing with age. Although many different hosts are given for this species by various workers, in this study it was not found outside of the bass, except for one instance of larvae encysted in liver of a common sunfish.

Leptorhynchoides thecatus (Linton, 1891).—This parasite was the most abundant of the Acanthocephala, and of all the worm parasites of Portage Lakes fishes. It was widely distributed in fish species, commonest in large-mouth black bass, bluegill; next commonest in hybrid sunfish, common sunfish, warmouth bass, and found also in other Centrarchidae and occasionally in other fishes. It occurred in stomach and intestine, sometimes so numerous in a host as to clog the intestine and tear the walls, and sometimes found in the coelom. Older hosts were more heavily infested.

In life cycle studies, Van Cleave (1920) showed that larvae lived in the Amphipod *Hyalella knickerbockeri*. This amphipod is also abundant in the Portage Lakes. It appears that larvae from these arthropod hosts swallowed by the fish may, presumably if too small, bore through the fish intestine wall and proceed with larval growth in a cyst within the viscera. Such encysted larval stages were found in various internal organs. Thus a fish may become an additional intermediate host.

Pomphorhynchus Monticelli; *Pomphorhynchus bulbocolli* Linkins.—This species was less abundant than the other two species but rather widely distributed. It was found chiefly in the goldfish and black bullhead, but also in yellow perch, long-eared sunfish, warmouth bass. It was in the intestine, except also in gonads in goldfish

The Acanthocephala are so abundant in most hosts as to cause serious damage. This has been discussed by Bangham (1928), Van Cleave (1919), and Pearse (1924). The damage to fishes in the present collections was often evident. When the intestinal lumen was clogged, laceration of walls with holes was frequent, resulting in inflammation and yellowing of the tissues.

Acanthocephala seem to be well adjusted to their parasitic existence. There is no free-living stage. Two hosts are always required. Larval hosts are Insects or Crustacea. (Van Cleave and Mueller, 1934). Since host-parasite relationship is not very specific, adults may be in many species of fishes, passing from one to another as a predator eats a small fish. A large predator might adopt the Acanthocephala of several host victims. This was shown in this study of the Centrarchidae of the Portage Lakes. All the Centrarchidae showed high percentage of infestation, except the white crappie. Practically every specimen of the others was infested heavily. In six white crappie no Acanthocephala were found. The identifiable stomach contents of the white crappie (six specimens) were the fry of gizzard shad, *Dorosoma cepedianum*, which is a fish now well known to feed almost exclusively on phytoplankton (Tiffany, 1921), and sometimes on bottom mud. This parasitically sterile fish, when serving as the food of white crappie, explains the nearly complete lack of parasitism of the crappie in the present instance.

Seasonal periodicity of Acanthocephala infestation was also noted. Winter fish collections were almost devoid of these worms of adult stage. The hosts feed little in the winter. Acanthocephala may overwinter more as larval forms.

Hirudinea.—Leeches are of relatively minor importance as fish parasites. A total of only four leeches were found on fish taken in this study. One of these was a leech of genus *Illinobdella*, from the skin of a warmouth bass, caught through the ice in February in Grape Lake, which is very shallow. The other three were not identified and were found on gills of black bullhead, and the roof of the mouth of a long-eared sunfish from the Ohio Canal, and the other from the fin of a bluegill from North Reservoir. There was no correlation between infestation and season or habitat type.

CORRELATION OF PARASITISM AND HABITAT

Because of the small areas involved, the differentiated habitats are not extensive, so that many fish may not be so fully restricted to one habitat. But they have their individual environment preferences. Some parasites also appear to have such restricted habitats, which is probably determined chiefly by the range of the intermediate hosts.

Parasitism occurs more in shallow than deep water; 28% of the fish taken in deep, open water were parasitized, but 73% of the fish taken in shallow water were infested. Of shallow water fish, 27% were infested with Trematodes, but only 4% from deep water had Trematodes. However, Cestodes were found in 44% of deep water fish and only 3% of shallow water fish, and thus in contrast to the other parasites.

Acanthocephala were predominately in the shallow water association, 56% of fish in shallow water as contrasted to 32% in deep water were infested. The fish taken from a hard bottom habitat were 95% infested with Acanthocephala; those taken from a soft bottom habitat were 44% infested.

In fact, hard-bottom, shallow-water habitat fish had the greatest infestation throughout, double that of the shallow-water, mud-bottom habitat fish and not quite double that of the deep-water, mud-bottom habitat fish, in latter of which tapeworms raised the percentage of infestation. Probably the explanation is largely that the carnivorous fish like Centrarchidae were mostly taken in the hard-bottom shallow water.

TABLE I

Percentage of Parasitism in Fish Families and Species

Family of Fishes	Number Examined		Percent Infested	
Species and Common Name	Fam.	Sp.	Fam	Sp.
Lepisosteidae	5		100	
Lepisosteus osseus, long-nosed garpike		5		100
Clupeidae	7		0	
Dorosoma cepedianum, gizzard shad		7		0
Cyprinidae	16		18.7	
Cyprinus carpio, carp		1		100
Carassius auratus, goldfish		1		100
Notropis whipplii, steel-colored minnow		1		100
Notemigonus crysoleucas, golden shiner		6		0
Hyborhynchus notatus, blunt-nosed minnow		7		0
Ameiuridae	5		80	
Ameiurus melas, black bullhead		5		80
Esocidae	1		100	
Esox vermiculatus, grass pike		1		100
Percidae	11		36.4	
Perca flavescens, yellow perch		3		66.6
Percina caprodes, log perch		8		37.5
Centrarchidae	66		89.7	
Huro salmoides, large-mouth black bass		19		100
Lepomis macrochiarus, bluegill		19		94.7
Eupomotis gibbosus, common sunfish		8		100
L. machrochiarus x *E. gibbosus*, hybrid sunfish		4		100
Ambloplitis rupestris, rock bass		1		100
Chaenobrytius gulosus, warmouth bass		7		71.4
Pomoxis annulairs, white crappie		6		16.6
Pomoxis sparoides, black crappie		1		100
Xenotis megalotis, long-eared sunfish		1		100
Atherinidae	16		0	
Labidesthes sicculus, brook silversides		16		0

AMOUNT OF PARASITISM IN THE FISHES

From the ecological point of view one is interested in the species of parasites a host harbors, the relative abundance of the parasite species, and also in the percentage of host specimens infested. Kinds of parasites and relative abundance have been presented above, together with relations of fish species. There is no room for detailed data for every fish examined, but a list of fishes, grouped by families, is given here (Table I), showing percentage of infestation of the fish species.

DEGREE OF PARASITISM WITHIN THE FISH FAMILIES CORRELATED WITH FEEDING HABITS

Of the total fish taken, 127, the number infested with one or more kinds of worm parasites was 76, or a percentage of 59.8, which by coincidence at least is practically the same as the 58.3% on a much larger number of Lake Erie fish, 2,156, found by Bangham and Hunter (1939). Essex and Hunter, 1926, working in the Central States, obtained a 39% infestation in 652 fish examined.

The number of fish examined is admittedly very small, especially for some species, but it seems that the data should give some idea of the fish parasite relation of many of the fish types of these inland lakes.

Consideration of the fishes by families is of some significance and allows for some generalization. It is not that phylogenetic relationship is of dominant importance, but food habits naturally are important in the matter of securing parasite infection and thus important for all fishes of a family having similar food habits. Where there is a striking exception, it can be seen that the difference in food accounts for the difference in parasites. Such is the case in the white crappie, utterly free of Acanthocephalan parasites, whereas all other Centrarchidae were heavily infested. (The percentage in the table for white crappie is due to a very light infestation of one of the six with a different but unidentified parasite.)

The families with high percentage of infestation are Lepisosteidae (100%), Ameiuridae (80%), Esocidae (100%), and Centrarchidae (89.7%).

The data on food of every fish taken was kept, but space limitation prevents inclusion here.

The records on Lepisosteidae and Esocidae are based on meagre catches here, but their food habits are well known. Ameuridae may have more versatile food habits, but the five black bullheads contained chironomid larvae and snails only. The food of all the 66 members of Centrarchidae was comprised of fish, crayfish, snails, chironomids and other insects, and some Cyclops and Cladocera in some young specimens. They were predominantly carnivorous.

These families included the so-called game fishes and similar forms.

One family, Percieae, more intermediate in degree of parasitism, comprises fish of versatile food habits.

The three families least parasitized were Clupeidae (0%), Cyprinidae (18.7%), and Atherinidae (0%). These are definitely non-game fishes.

The gizzard shad of the Clupeidae (already referred to) feeds largely on phytoplankton and may take some mud. The Atherinidae feed primarily on plankton, (Sibley, 1929). Many of the Cyprinidae are known to be bottom feeders and scavengers and to a large extent feed also on plankton. For example, the blunt-nosed minnow is typical as well as versatile, as shown in a food study from these same waters, (Kraatz, 1928).

It is clear that those fishes whose main diet is plankton and especially those feeding on phytoplankton, and bottom materials, show no parasitism or low degree of parasitism.

CORRELATION OF PARASITISM WITH AGE OF HOST

The parasitic fauna often changes markedly with age, a consequence of changing food habits. Most fish feed on minute Crustacea and other plankton when young, thus acquiring those parasites which utilize some of the smaller Arthropods as hosts, such as the Acanthocephala. As the fish grows older, if carnivorous, it begins to capture larger animal forms and then becomes exposed to other parasitic worms, such as trematodes and cestodes. Data are here presented for the bluegill and large-mouth black bass. The Acanthocephalan *Leptorhynchoides thecatus* is found in both the young and mature bluegill and bass. The cestodes and trematodes occur only in the more mature bluegills. In the large-mouth bass, however, *Neascus amblopliitis* appears primarily as a parasite of the immature fish, although the cestode *Proteocephalus amblopliitis* is found only in the older fish. Because of their larger size and more voracious appetite the large-mouth bass might be infested by trematodes while still relatively young.

TABLE II

EFFECT OF AGE ON PARASITISM

Figures show percent of fish infested

Parasite	Bluegill		Largemouth Bass	
	Under 4"	Over 4"	Under 6"	Over 6"
L. thecatus	91	88	77	100
P. amblopliitis	0	25	0	50
N. vancleavii	0	25	8	17
N. amblopliitis	0	17	69	0

SUMMARY

A total of 127 fish, representing 21 species of 8 families, were taken from the Portage Lakes.

Parasites were studied. Most were endoparasites, a few leeches being the only ectoparasites. The classes Trematoda, Cestoda, Nematoda, Acanthocephala were represented; the Nematoda least of these.

Acanthocephala, with *Leptorhynchoides thecatus* in intestine, strikingly abundant, were the most common and widespread parasites. *Neoechinorhynchus cylindratus* was second in abundance of thorny-headed worms.

The trematode, occurring as metacercariae, *Neascus vancleavii* was also often abundant in liver and *Neascus amblopliitis* as a skin encysted parasite.

Shallow water fish exhibit a higher degree of parasitism than deep water fish and those from a hard bottom more infested than those of a mud bottom. But Cestodes were commoner in deep water fish.

Food habits have a marked relationship with parasitism Families Clupeidae, Atherinidae and Cyprinidae, which are more herbivorous and bottom and general feeders, had a collective percentage of parasitism of only 7.7%.

The five other families, Lepisosteidae, Ameiruidae, Esocidae, Percidae, and Centrarchidae, showed a collective infestation of 83.5%. These are chiefly carnivorous, and many of them game fishes. The Percidae were least infested of these five, and they are less carnivorous than the other four families.

There is some correlation of parasitism with age of host, parasitic fauna changing with the changing food habits of the growing fish.

Of the 127 fish, 76 or 59.8% harbored one or more species of worm parasites

LITERATURE CITED

Agersborg, B. P. K. 1926. Studies on the affect of parasitism upon the tissues. II. With special reference to a new Diplostomous trematode found in the minnow *Notropis anogenus* Forbes. Arch. f. Schiffs-u. Tropen-hyg., 30: 18–30.

Bangham, R. V. 1925. A study of the cestode parasites of the black bass in Ohio, with special reference to their life history and distribution. Ohio Jour. Sci., 25: 255–262.

1927. The life history of cestode *Proteocephalus amblopliitis*. Trans. Amer. Fish Soc., 47: 206–208.

1928. Parasites of black bass. Sci., No. 27: 267–270.

1928a. Distribution of parasites of black bass in lakes and streams of Ohio. Ohio Cons. Bull., 17.

Bangham, R. V., and **Hunter, G. W., III.** 1939. Studies of fish parasites of Lake Erie. Distribution studies. Zoologica, 24: 385–448.

Essex, H. E. 1928. The structure and development of Corallobothrium with descriptions of two new fish tapworms. Ill. Biol. Monogr., II (3): 1–75.

Essex, H. E., and **Hunter, G. W., III.** 1926. A biological study of fish parasites from the Central States. Trans. Ill. Acad. Sci.

Hare, Robert C. 1941. An ecological study of the worm parasites of Portage Lakes Fishes. (Unpublished thesis, University of Akron.)

Hughes, R. C. 1927. Studies on the trematode family Strigeidae (Holostomidae) VI. A new Metacercaria Neascus ambloplitis, sp. nov., representing a new larval group. Trans. Amer. Micros. Soc., 46: 248–267.

Hunter, G. W., III. 1928. Contributions to the life history of *Proetocephalus ambloplitis* (Leidy). Jour. Parasitol., 16: 229–242.

Kraatz, W. C. 1928. Study of the food of the blunt-nosed minnow, *Pimephales notatus.* Ohio Jour. Sci., 28: 2: 86–98.

1931. A quantitative net-plankton survey of East and West Reservoirs, near Akron, Ohio. Ohio Jour. Sci., 31: 6: 475–500.

1941. Quantitative Plankton studies of Turkeyfoot Lake, near Akron, Ohio. Ohio Jour. Sci., 41: 1: 1–22.

La Rue, G. R. 1914. A revision of the cestode family Proteocephalidae. Ill. Biol. Monogr., 1: 1–350.

Linton, R. 1891. A contribution to the life cycle of *Dibothrium cordiceps*, a parasite infesting the trout of Yellowstone Lake. Bull. U. S. Fish Comm., 9: 337–358.

Osburn, R. C. 1921. Report on the fish conditions in the Portage Lakes. Ohio Sportsmens Bull. I.

Pearse, A. S. 1924. Observations on parasitic worms from Wisconsin fishes. Trans. Wis. Acad. Sci., Arts, Letters, 21: 147–160.

Sibley, C. K. 1929. The food of certain fishes of the Lake Erie drainage basin. Suppl. 18th Ann. Rept. N. Y. State Cons. Dept., 1928: 180–188.

Tiffany, L. H. 1921. Algal food of the young gizzard shad. Ohio Jour. of Sci., 21: 113–122.

Van Cleave, H. J. 1913. The genus Neoechinorhynchus in North America. Zool. Anz., 43: 177–190.

1919. Acanthocephala from the Illinois River, with descriptions of species and a synopsis of the family Neoechinorhynchidae. Bull. Ill. Nat. Hist. Surv., 13: 222–257.

1920. Notes on the life cycle of two species of Acanthocephala from fresh-water fishes. Jour. Parasitol., 6: 167–172.

Van Cleave, H. J., and **Mueller, J. F.** 1934. Parasites of Oneida Lake fishes. Part III. A biological survey of the worm parasites. Roosevelt Wild Life Annals, 7: 159–335.

Ward, H. B. 1894. Some notes on the biological relations of the fish parasites of the Great Lakes. Proc. Neb. Acad. Sci., 4: 8–11.

1901. Notes on the parasites of lake fish. III. On the structure of the copulatory organs in Microphallus nov. gen. Trans. Amer. Mic. Soc., 22: 175–187.

Ward, H. B., and **Magath, T. B.** 1917. Notes on some nematodes from fresh-water fishes. Jour. Parasitol., 3: 57–64.

A Survey of Biology

This book provides an excellent organization of subject matter that might be included in a survey course of biology for underclassmen of colleges or universities. It can also be recommended to the layman who desires a general cultural knowledge of biology and its integration with liberal education. It is refreshing to find that a book of this scope can be written about the broad generalizations necessitated by its functions and yet make little or no sacrifice of the accurate factual information upon which these biological principles must be based. The four chief subdivisions concern the organism in its aspects as 1) an individual, 2) a member of its race, 3) a product of evolution and 4) a unit in a social-economic complex. The first subdivision discusses the structures and functions of the human body and this is followed by a similar analysis of a typical seed plant. This section as well as that on evolution is outstanding, giving one an excellent picture of man's position in this world of living things. Perhaps some biologists, including this reviewer, would desire more emphasis on human inheritance, taxonomic relationships, and the broader aspects of ecology such as geographical distribution, social behavior, conservation, personal and public health programs. The physical make-up of the book is attractive and there are sufficient illustrations. The appendix includes a brief survey of the plant and animal kingdoms, general references and a glossary.—*J. G. Haub.*

Man and the Biological World by J. Speed Rogers, Theodore H. Hubbell and C. Francis Byers. 607 pp. New York, The McGraw-Hill Co., 1942. $3.50.

A NEW PRAIRIE SPIDER

W. M. BARROWS

Department of Zoology and Entomology,
Ohio State University

Many years of careful collecting in the prairie regions of the State of Ohio have yielded several new species of spiders. Among them is the following:

Souessa nasuta n. sp.

Male.—Length 1.8 mm. The thorax is dull yellow suffused with sooty black. The legs and basal segments of the palps are light yellow. The projecting clypeus is light yellow above and below. The sternum is dull yellow heavily covered with sooty black. The abdomen is light yellow dusted with sooty black giving the appearance of being dull green. The sooty covering is speckled with tiny pin points of yellow and crossed by many bright rays of yellow which for the most part are directed laterally or posteriorly. Starting between the second pair of muscle impressions is a narrow sooty line which runs backward becoming narrower. The venter of the abdomen is dull green with two light boundary streaks which bow outward The spiracle is marked by a long light colored procurved line which is expanded at the ends

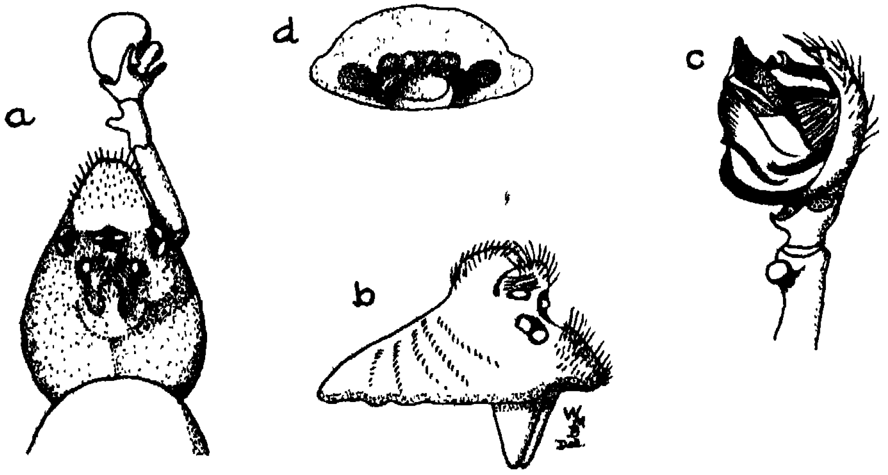


FIG. 1. *Souessa nasuta* Barrows. a. Dorsal view of male. b. Side view of male cephalothorax. c. Palpal organ of male. d. Epigynum of female.

The palpal organ is much like that of *Souessa spinifera* Camb.[1] except that the two terminal teeth are twisted around each other. The patella of the palp carries on its distal end a spur which projects downward and inward (Fig. 1, a and c).

Fig. 1, b shows a lateral view of the male cephalothorax.

Female.—Length 1.9 mm. The colors and markings are the same as the male in every detail. The head is normal except that the clypeus is high, broadly rounded in front, and flares forward and outward.

The epigynum is shown in Fig. 1, d.

Two males in prairie northwest of West Jefferson, Ohio. Sept. 23, 1923.

Five females from the same place Oct. 19, 1924.

---

[1] Crosby and Bishop, Festschrift fur Embrik Strand. Riga, 1936-37, II, p. 57.

A NEW SPECIES OF ASTRAEOSPONGIA FROM THE MIDDLE DEVONIAN OF OHIO

JOHN W. WELLS,
The Ohio State University, Columbus, Ohio

In the course of a study of the Middle Devonian bone beds of Ohio and adjoining states a rich thanatocoenotic microfauna has been found in them, including many new types of skeletal parts of fishes together with lesser numbers of conodonts, ostracods, and foraminifera. Spicules of sponges are much rarer than other remains and all that have been found so far seem to pertain to a new species of the peculiar octactinellid, *Astraeospongia*, described below.

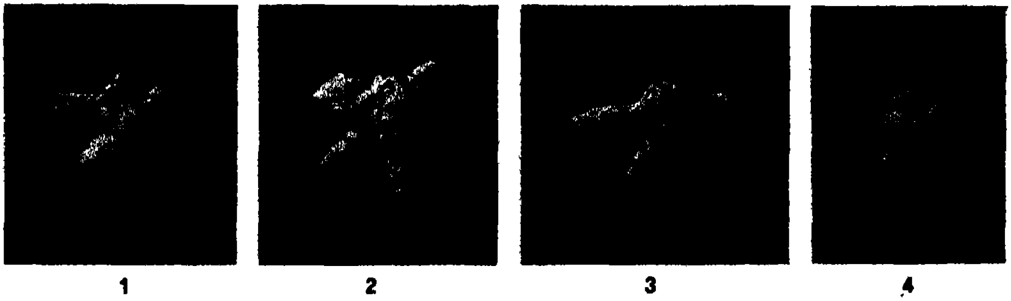
Family OCTACTINELLIDAE

Genus **Astraeospongia** Roemer 1860

Astraeospongia ohioensis n. sp.

(Figures 1–4)

Description.—Known only from isolated beekitized spicules. Two specimens (Figs. 1, 2) have six horizontal rays and two vertical ones, the latter equal in length to the horizontal ones. In two other specimens (Figs. 3, 4) the vertical rays are mere protuberances scarcely one-fifth the length of the horizontal rays. Total diameter across opposite horizontal rays, 1 to 1.5 mm. Rays club-shaped or bluntly cylindrical, about 0.25 mm. thick, fixed to a well-developed central disc.



1 2 3 4

Astraeospongia ohioensis, n. sp.

FIG. 1. Holotype (O. S. U. No. 19486), Columbus ls. bone bed, Marion Co., O.; 2, O. S. U. No. 19485, Columbus ls. bone bed, Franklin Co., O.; 3, O. S. U. No. 19487, Columbus ls. bone bed, Crawford Co., O.; 4, O. S. U. No. 19488, upper Columbus ls., Ottawa Co., O. All spicules enlarged 25×.

Occurrence and Material.—(a) In the bone bed at the top of the Columbus formation at the following localities: (1) J. and L. Snouffer quarry, east side of Scioto River, one mile south of Dublin, Franklin County, Ohio (1 specimen, O. S. U. 19485); (2) J. M. Hamilton and Sons quarry, east of highway 1.75 mi. north of Marion, Marion County, Ohio (2 specimens, including holotype, O. S. U. 19486); (3) National Lime and Stone Co. quarry on Broken Sword Creek, 1 mi. northwest of Spore, about 6 mi. northwest of Bucyrus, Crawford County, Ohio (1 specimen, O. S. U. 19487).

(b) In the uppermost part of the Columbus formation in a road cut on the south side of Marblehead peninsula 2.5 mi. west of south of Lakeside, Ottawa County, Ohio (1 specimen, O. S. U. 19488).

Remarks.—This form is marked by the small size of the spicules which are on the average less than half as big as those of other Devonian species. In *A. devoniensis* Hinde (1887, p. 140, pl. 4, figs. 8–8c) from the Middle Devonian of Devonshire, the spicules are larger (2.5 to 5 mm.), with thinner, longer, more attenuate rays. *A. meniscoides* Dewalque (1872, pp. 23–26, pl. 1) from the Middle Devonian of Belgium and the Eifel, has larger spicules (4 mm.) with no vertical rays and fusiform horizontal rays. *A. hamiltonensis* Meek and Worthen (1868, p. 419, pl. 10, fig. 6) from the Middle Devonian of Iowa, also has larger spicules (3.25 mm.) that seem to lack vertical rays and with horizontal ones 0.5 mm. in thickness and 1.5 mm. long. In *A. rhenanum* (Schlüter) (1887, p. 23, pl. 2, figs. 7–9), from the Middle Devonian of the Eifel, the spicular rays are relatively very long and slender, needle-like, 0.2 to 0.4 mm. thick, the total diameter of the spicules being 3 or 4 mm.; the central disc is very small and the vertical rays well-developed.

REFERENCES CITED

Dewalque, G. 1872. Un spongiaire nouveau, du système eifelien. Acad. Roy. Belgique, Bull., 34: 23–26, pl. 1.

Hinde, C. J. 1886–1911. Monograph of the British fossil sponges. Vol. 1, Sponges of Palaeozoic and Jurassic Strata. Palaeont. Soc. London, pp. 1–92; pls. 1–8 (1886); 93–188, pl. 9 (1887); 189–254, pls. 10–19 (1893); 255–264 (1911).

Meek, F. B. and Worthen, A. H. 1868. Fossils of the Hamilton group. Geol. Surv. Illinois, 3: 419–449, pls. 10–13.

Schlüter, C. 1887. Ueber Scyphia oder Receptaculites cornucopiae Goldf. sp. und einige verwandte Formen. Zeitschr. d. g. Ges., 39: 1–26, pls. 1–2.

Ways of the Weather

Everyone talks about the weather and no one can do anything about it. In a scholarly treatise Humphreys, a veteran weatherman of forty years experience, gives a comprehensive discussion of its various aspects. He presents only the most elementary knowledge of the weather by his readers, and discusses in detail not only such subjects as Structure of the Atmosphere, Distribution of Temperature, Water Vapor and Atmospheric Pressure, Wind and Precipitation, but also the meteorological instruments employed and gives considerable history of the science. Of special interest are the chapters on such unusual subjects as Weather Music, Weather Perceptions, Atmospheric Electricity and Atmospheric Optics.

The literary style employed is of an unusually fine quality. The author does not hesitate to use rhyme and verse when appropriate. For example, "even the big eddies have smaller eddies upon them and the smaller eddies lesser eddies. As L. F. Richardson puts it,

'Big whirls have little whirls that feed on their velocity,
And little whirls have lesser whirls and so on to viscosity.' "

The reader gains the impression that the writer knows what he is talking about, and that he has not sacrificed scientific accuracy on the altar of popular appeal. Indeed, the seeker of easy and complete answers may be disappointed in this book. It is not light reading and in some instances the gleaning of worthwhile information is made tedious by unnecessary details.

The volume is attractively bound and a splendid grade of paper is used. It is replete with excellent illustrations. Anyone interested in the "ways of the weather," and this includes most of us, should find this book an illuminating reference.—*D. C. Rife.*

Ways of the Weather, by W. J. Humphreys, the Jaques Cattell Press, Lancaster, Pa., 1942. $4.00.

Ohioans in Aviation

Dayton, Ohio, is the place where Wilbur and Orville Wright were born and lived the greatest part of their lives. It was here that they designed and conducted the first wind tunnel experiments in history. The principles thus scientifically discovered enabled them to succeed where others had failed. The real achievement of this book, however, is not a eulogy on the significance of their activities. It is an interesting, well documented account of the experiences and personal reactions to them which the Wrights had. Such an intimate personal analysis was possible only because Orville Wright himself participated by making a mass of original documents available to the author, by reading the entire manuscript, and by suggesting corrections. Here is the true story of the Wright Brothers as they lived it.—*Elton F. Paddock.*

The Wright Brothers, by Fred C. Kelley. Harcourt, Brace and Company, New York, 1943. 340 pp. $3.50.

TWO NEW ULOTRICHALES

EDGAR N. TRANSEAU
Department of Botany, The Ohio State University,
Columbus, Ohio

Following are descriptions of two new species of green algae that are of interest because each contributes to our concept of the genus to which it belongs. Both descriptions have been held for some years in manuscript form in the hope that the plants might be studied cytologically before publication.

Chaetonema ornatum sp. nov.

Filaments straight or irregular, with shorter lateral branches more or less at right angles to the filament, imbedded in the pectic sheath of *Tetraspora* and *Draparnaldia*. Vegetative cells at first 7 to 10μ in diameter, and 15 to 30μ long, later becoming enlarged toward the middle to 14 to 20μ, often with one to four rather short setae. Reproduction by swimming spores, one or two of which may be formed within an enlarged vegetative cell. Development of two spores follows immediately after division of the protoplast, with or without the formation of a separating wall. The spores are 11 to 15μ in diameter.

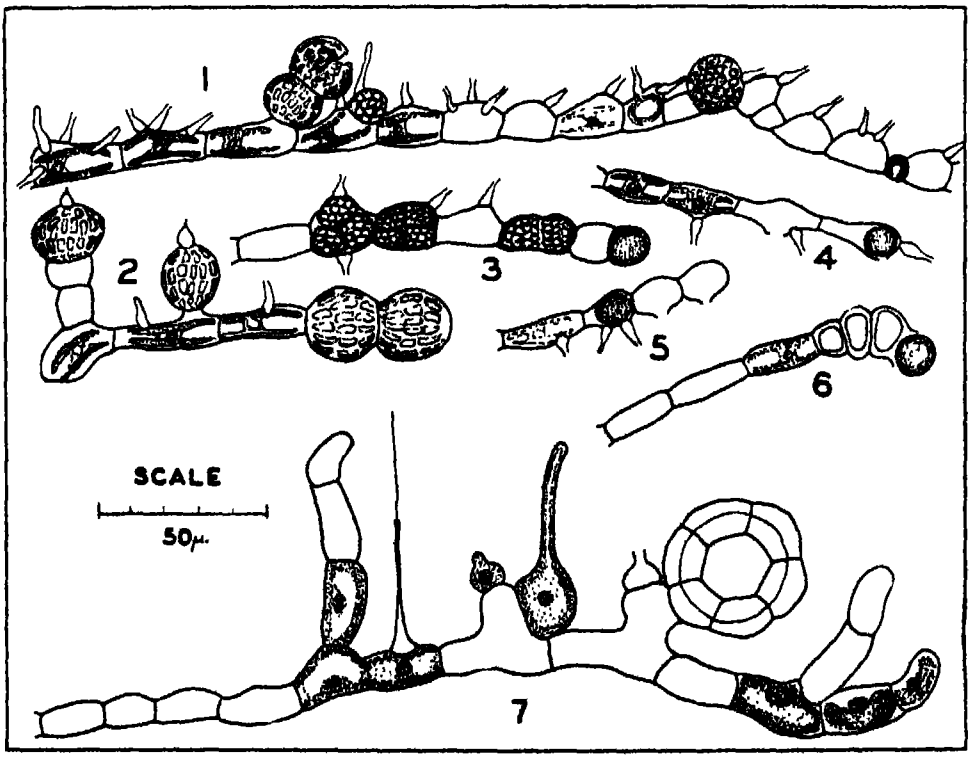


FIG. 1. *Chaetonema ornatum*, filament with vegetative cells, 2 antheridia and 2 oogonia. FIG. 2. Part of a filament with mature oogonia only. FIG. 3. A filament with antheridia and sperm masses, also a terminal sporangium containing a swimming spore. FIGS. 4, 5, and 6. Vegetative cells and sporangia with swimming spores. FIG. 7. *Coleochaete sampsonii*, filament with seta, immature antheridium and oögonium, and mature oögonium.

Sexual reproduction occurs by the union of eggs and sperms formed in oögonia and antheridia. The oögonia usually develop singly, or in pairs, on lateral branches, or from the terminal cells of main filaments. Oögonia are nearly globose, 18 to 22μ in diameter, with or without a terminal seta. Occasionally the oögonia are ovoid and up to 28μ long. The oögonial wall is marked by oblong pits, arranged more or less zonally.

Antheridia form in cells, either of the main filament or of lateral branches, either before a principal division of the protoplast occurs, or following one or two divisions. Each daughter protoplast then divides internally, and apparently 32 to 128 sperms result.

Apparently the plant is monoecious, but there are filaments present in the material that are forming only antheridia, others only oögonia, and still others only swimming spores.

This species was first collected on *Tetraspora*, from a pond near Birmingham, Alabama, April 11, 1925. In 1941 and 1942 it was again found by Dr. Elwyn Hughes in Halifax, Queen's and Lunenberg counties, Nova Scotia, where it was epiphytic on *Tetraspora* and *Draparnaldia*.

Thallus epiphyticus, e filamentis irregulariter ramosis; ramuli rectangulariter exeuntes, distantes. Cellulis vegetativis vel subcylindricis vel unilateraliter inflatis; 1–4 setas gerentibus, 7–10μ latis, 2–4– plus longioribus; oogoniis subglobosis 18–22μ latis. Fig. 1–6.

Coleochaete sampsonii sp. nov.

During August, 1932, Dr. Homer C. Sampson collected algae in the vicinity of the Fulton Chain of Lakes in the western Adirondacks, New York. Among the collections were several vials containing species of *Batrachospermum* from Quiver and Round Lakes. In the surface of the pectic sheaths there were large numbers of a small and very simple *Coleochaete* resembling *C. pulvinata* in its mode of branching. In August, 1933, the plants were again found in abundance and this material contains all stages in the development of the reproductive organs. In the summer of 1934 the lakes were extremely low and the banks were exposed to the air and no specimens were found. In September, 1935, the water was unusually high and neither the *Batrachospermum* nor the *Coleochaete* could be found at any of the former localities, possibly because of previous fluctuations in the water levels. The species differs from *C. pulvinata* in its smaller dimensions, its spheroidal oöspore and the simplicity and regularity of the cortication of the oögonium. Following are the characteristics of this species:

Monoecious, filaments branching, prostrate, very irregular; cells 7 to 14μ x 14 to 36μ, irregularly curved, cylindric or enlarged near the middle; young oögonium with an elongated trichogyne; mature oögonium globose, corticated, 35 to 38μ in diameter; antheridia small globose or pyriform cells that arise laterally from the vegetative cells; oöspore 29 to 36μ in diameter. Fig. 7.

Thallus epiphyticus, e filamentis varie ramosis; cellulis vegetativis 7–14μ latis, 14–36μ longis, irregulariter curvatis, vel cylindricis vel in medio tumidis; oogoniis globosis, corticatis, diametro 35–48μ oosporis globosis diametro 29–36μ; antheridiis vel globosis vel piriformibus.

Blood Groups and Transfusion

The third edition of Blood Groups and Transfusion is a comprehensive and authoritative treatise of the subject. It is a notable improvement over and enlargement of the second edition. Two new chapters have been added, one dealing with the transfusion of stored blood and blood substitutes, and the other with the Rh factor. So many changes were made in the other twenty chapters that the book was reset from new type. Detailed discussions of the four blood groups, the history of blood transfusion, and the techniques and results of transfusions are given. The most recent advances in regard to knowledge of the M and N agglutinogen the subgroups of A and AB, the P and X agglutinogens, and the secretor substances are considered. Substantial additions are included in the discussion of the racial distributions of the blood reactions. The genetics of the various blood reactions is thoroughly presented. This new edition should be cordially welcomed by physicians, students of human heredity and physical anthropologists.

—*D. C. Rife.*

Blood Groups and Transfusion, by Alexander S. Weiner. pp. 438. Charles C. Thomas, Springfield, Ill. 1943. $7.50.

STUDIES OF THE GENUS EMPOASCA (HOMOPTERA, CICADELLIDAE)

PART X.[1] FOURTEEN NEW SPECIES OF EMPOASCA FROM MEXICO

RALPH H. DAVIDSON AND DWIGHT M. DELONG
Department of Zoology and Entomology,
Ohio State University

This paper is a continuation of our study of the leafhoppers in the genus *Empoasca*. It deals entirely with species taken in Mexico. Species previously described by us from Mexico are as follows: ***serrula***, ***dampfi***, ***arator***, ***prona***, ***resupina***, ***duodens***, ***ingena***, ***obstipa***, ***crocostigmata***, ***crocovittata***, and ***omani*** variety ***iguala***.

Empoasca caraba n. sp.

Resembling *madra* somewhat in shape of lateral processes but with extra processes on aedeagus and a distinctly different dorsal spine. Length 3.5 mm.

External characters.—Frons, clypeus, vertex, pronotum and scutellum yellowish. Vertex slightly produced with a median stripe of white which extends across both the pronotum and scutellum. A white spot on each side of median line of vertex. Whitish spots on each side of median line of pronotum. Wings subhyaline with faint golden stripes, apices smoky. Female last ventral segment rounded with a slight median notch.

Internal male genitalia.—Lateral processes heavy, broad at base, tapering gradually caudad to pointed tips that are directed slightly dorsad and gently curved outward. Aedeagus broadened medially with a sharp-pointed apical portion that is directed caudad and dorsad. A pair of long, straight, slender, pointed, processes arise at base of enlarged portion which are directed caudad and dorsad, ending just before apex of aedeagus. The anterior projecting processes connect to the base of the dorsal spine which is broad, directed ventrad, but narrowed abruptly to a pointed slightly anteriorly directed tip.

Holotype male, allotype female, and a large series of male and female paratypes from Carapan, Mich., Mexico, (432 Km.[2]) 10-2-41, collected by DeLong, Good, Plummer, and Caldwell. Also male and female paratypes from Mexico City, Mex. (west 18 Km.) 9-1-39, collected by DeLong; Toluca Road, Mexico, 11-24-38, collected by Caldwell; Tres Cumbres, D. F. (52 Km.) 10-21-41, collected by DeLong, Caldwell, Good and Plummer; Zitacuaro, Mich., (160 Km.) 9-29-41, and Tuxpan, Mich., (185 Km.) 10-5-41, collected by the same men. Types deposited in the authors' collections.

Empoasca stalsisa n. sp.

A small species that appears to be in the *alboneura* group. The lateral processes and dorsal spine are characteristically shaped. Length 3 mm.

External characters.—Color orange-red with smoky spots on the forewings. Vertex slightly produced with a median whitish longitudinal stripe which continues faintly across the pronotum and a white spot on each side next to the eyes. In some specimens, there is another faint whitish spot back of each of those next to the eyes. Pronotum with a median and two lateral whitish spots on anterior margin. Wings hyaline with smoky spots. Female unknown.

Internal male genitalia.—Lateral processes broad basally, narrowed, than gradually broadened, directed caudad and dorsad to pointed tips. In ventral view they are very broad just before the apex. Aedeagus at apex appearing hour-glass shaped in ventral view. Near base of enlarged portion are anteriorly projecting pieces which connect to the base of the broad, curved, gently rounded dorsal spine.

---

[1] Previous parts of this study have appeared as follows: Ohio Journal of Science, **32**: 393-401; **35**: 29-39; **36**: 225-230; **38**: 90-96; **39**: 110-118; **42**: 123-126; and Annals of the Entomological Society, **27**: 604-609; **33**: 606-611; **35**: 105-109.

[2] Distance from Mexico City in kilometers.

Holotype male, and a series of male paratypes from Iguala, Guerrero, Mexico, 9-11-39, collected by Dr. DeLong and a male paratype from Santa Engracia, Mexico, 11-8-38, collected by Dr. J. S. Caldwell. Types deposited in the authors' collections.

Empoasca semanta n. sp.

A small species with characteristic internal male genitalia and dorsal spine. Length 2.5 mm.

External characters.—General coloration orange-yellow to light brown. Vertex rounded with a median and two lateral ivory spots. Three ivory spots near anterior margin of pronotum. Forewings tinged dark golden with smoky apices. Hindwings hyaline. Female unknown.

Internal male genitalia.—Lateral processes tapering gently, curving upward to pointed tips which are directed posteriorly and curved slightly outwardly. Aedeagus becoming broadened medially, with a long dorsally directed slightly curved apex and an anteriorly directed portion which is connected to the dorsal spine. Dorsal spine broad at base tapering quickly to a narrow, ventrally and anteriorly directed apex.

Holotype male, and 19 male paratypes from Iguala, Guerrero, Mexico, 9-11-39, collected by the junior author. Types deposited in the authors' collections.

Empoasca cerata n. sp.

Resembling *ingena* in coloration but with long lateral processes similar to *curvata*. Length 3.5 mm.

External characters.—General coloration pale to white marked with reddish to brownish spots. Vertex roundedly produced, with a median black longitudinal line, reddish centrally and lighter near the eyes. Ivory spots surrounding ocelli and a small comma-shaped spot on each side of median black line. Pronotum dark reddish brown with a whitish triangular spot back of each eye. Scutellum dark reddish-brown. Wings sub-hyaline with forewings spotted reddish-brown. Female unknown.

Internal male genitalia.—Lateral processes tapering gradually posteriorly to pointed tips which are directed upward and curve outward. Upper fourth of aedeagus enlarged with a posteriorly directed spine near base of enlargement and an anterior projection connecting to the base of the dorsal spine. Dorsal spine narrowed, directed downward to an anteriorly pointed tip.

Holotype male, and male paratype from Carapan, Mich., Mexico, (432 Km.) 10-2-41, collected by DeLong, Plummer, Good, and Caldwell. Types in the authors' collections.

Empoasca caldwelli n. sp.

A large species with distinct characters of the male genital chamber but resembling those of *thela* and *dilitara*. Length 4 mm.

External characters.—General coloration yellowish. Vertex rounded, with a median and two lateral ivory spots. Pronotum with four irregular ivory spots on anterior margin. Scutellum with two median longitudinal ivory stripes. Wings hyaline with forewings slightly tinged with yellow. Female last ventral segment truncate.

Internal male genitalia.—Lateral processes narrowed at basal half, becoming broader, directed posteriorly and curving upward to pointed tips which appear claw-like. Aedeagus broadened near upper portion with a long anteriorly curving apex and an anteriorly projecting basal portion connecting to the dorsal spine. A long narrow caudal process parallels the upper portion of the aedeagus and arises at base of broadened portion. Dorsal spine lobe-like, directed ventrally with a rounded blunt apex.

Holotype male, allotype female, and a male paratype from Mexico City, Mexico, collected by Dr. A. Dampf on 10-18-32, 10-27-31, and 8-5-32 respectively. Types deposited in the authors' collections.

The authors take pleasure in naming this species after Dr. J. S. Caldwell who has collected and described many species of Homoptera.

Empoasca bispinata n. sp.

Resembling *bifurcata* and other species of the *fabae* group, but with characteristic spines on the aedeagus. Length 3 mm.

External characters.—General coloration golden to pale yellow. Vertex with ivory spotting and a very narrow, median, dark, longitudinal line. Pronotum with three ivory spots on anterior margin; scutellum with median, longitudinal ivory striping and an ivory spot on each anterior corner. Forewings subhyaline with a faint yellowish tinge. Female last ventral segment rounded and slightly produced.

Internal male genitalia.—Lateral processes small, narrow, tapering gradually and curving caudally and slightly dorsally to pointed tips. Aedeagus narrow with a dorsally directed apex and a pair of medially located divergent sharp spines which are directed caudad. Dorsal spine notched at the apex forming two pointed tips, which are directed slightly anteriorly, the ventral one being the longest.

Holotype male and allotype female from Finca Vergel, Chiapas, Mexico, collected by Dr. A. Dampf on 5–22–35 and 5–19–35 respectively. Types deposited in the authors' collections.

Empoasca acantha n. sp.

A spotted species with characteristic shape of lateral processes and dorsal spine. Length 3 mm.

External characters.—Frons and clypeus brown with a median white stripe which continues over the vertex to the pronotum. A white dot on each side of median line of vertex and a white stripe next to each eye. Pronotum brown with a white median spot and two lateral white spots on anterior margin. Wings brown with subhyaline spots and smoky apices. Female last ventral segment roundedly produced.

Internal male genitalia.—Lateral processes, in lateral view broad at base, and bending rather abruptly at two points to form upward pointing tips. Aedeagus narrow, apical fourth slightly enlarged with caudal portion rounded and pointed upward and an anteriorly produced piece which connects to the dorsal spine. Dorsal spine broad at base, gradually tapering to a pointed apex which is directed ventrally and slightly anteriorly.

Holotype male from Acapulco Road, Mexico, 11–22–38, collected by Dr. J. S. Caldwell. Female allotype and a male paratype from Tres Cumbres, D. F. Mexico, (52 Km.) 10–21–41, collected by DeLong, Caldwell, Plummer and Good. Types deposited in the authors' collections.

Empoasca rumexa n. sp.

Resembling *sativae* externally but with characteristic shape of lateral processes and heavy dorsal spine as in *delongi*. Length 2.5 mm.

External characters.—Color golden yellow with white spots. Vertex slightly produced with a median and two oblique white spots on the dorsal side. Pronotum with a median broadly wedge-shaped white spot and lateral white spots on anterior margin. Scutellum with a median longitudinal white stripe. Wings hyaline with the first pair slightly tinged with yellow. Female unknown.

Internal male genitalia.—Lateral processes gradually tapered, curving upward to pointed tips which are bent inward. Aedeagus enlarged and rounded at apex with anterior processes arising at base of enlargement and connecting to the base of the dorsal spine. Dorsal spine heavy and long, tapered to a pointed tip directed ventrally and slightly anteriorly.

Holotype male, and male paratypes from Iguala, Guerrero, Mexico, 9–11–39, collected by the junior author and deposited in the authors' collections.

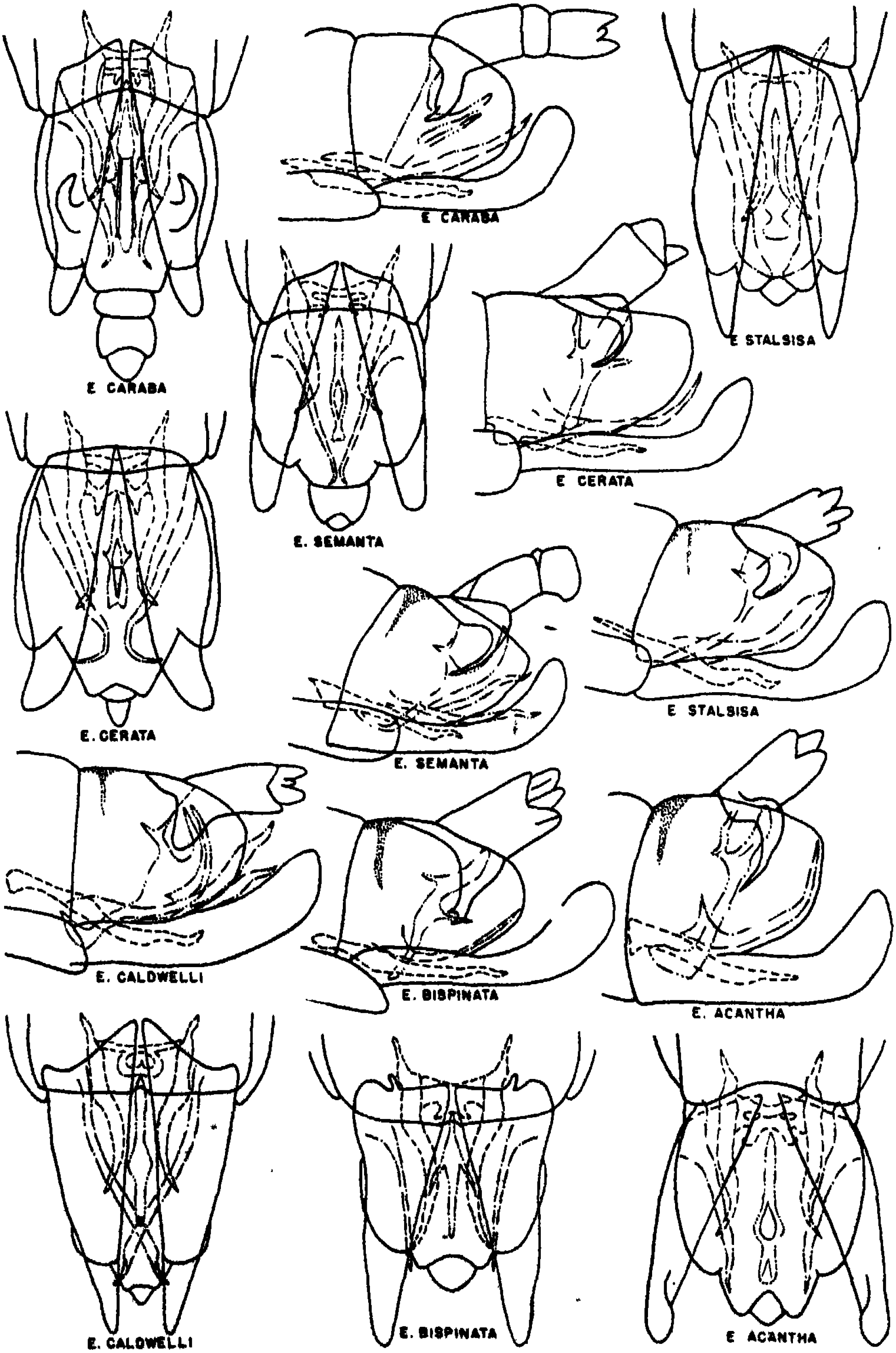
Empoasca adexa n. sp.

A small spotted species resembling *acantha* in coloration but with distinctly different lateral processes and dorsal spine. Length 2.5 mm.

External characters,—Frons and clypeus brown with a median white stripe which continues over the vertex to the pronotum. On each side of the median line on margin of the vertex is a

Ralph H. Davidson and Dwight M. DeLong
New Species of Empoasca

PLATE I



Ventral and lateral views of the posterior end of the abdomen showing the internal pieces of the male genital chamber.

white dot and a dash of white next to each eye. Dorsally the vertex has a white spot on each side of posterior margin next to the eyes. Pronotum brown with a median gray longitudinal stripe, a white spot behind each eye and a thin median white spot on anterior margin. Wings brown with subhyaline spots. Female last ventral segment rounded and produced medially.

Internal male genitalia.—Lateral processes small, tapered gradually, curving caudally and dorsally with the rather pointed tips directed inwardly. Aedeagus narrow with apical third enlarged, rounded and directed dorsally with an anterior dorsally produced piece near base of enlargement which connects to the dorsal spine. Dorsal spine broad at base tapering gradually and curving ventrally and anteriorly to a bifid apex, which is curved slightly inward.

Holotype male, allotype female and male and female paratypes from Carapan, Mich., Mexico (432 Km.) 10–2–41, collected by DeLong, Good, Caldwell and Plummer. A male paratype from Acapulco Road, Mexico, 11–22–38, collected by Dr. J. S. Caldwell. Types deposited in the authors' collections.

Empoasca serpula n. sp.

A small species resembling *galluxa* in shape of lateral processes, but with a very long curved dorsal spine by which the separation can be easily made. Length 2.5 mm.

External characters.—Frons, clypeus, vertex, pronotum and scutellum yellow to golden. Vertex slightly produced with a faint median line and a dash of white on each side. Pronotum with two median and two lateral white spots on anterior margin. Wings subhyaline. Female last ventral segment truncate.

Internal male genitalia.—Lateral processes short, slender, about same length as the styles, gently curving dorsad to inwardly curved tips. Aedeagus near apex long, narrow and dorsally directed, with anteriorly projecting pieces which connect to the base of the long narrow curving dorsal spine that almost parallels the pygofers. The tips of the spine are gently curved inward.

Holotype male, allotype female, and two male and one female paratypes from Iguala, Guerrero, Mexico, 9–11–39, collected by DeLong; one male paratype from Mexico City, 9–19–31, collected by Dr. A. Dampf. Types deposited in the authors' collections.

Empoasca bulba n. sp.

Resembling *bicorna* in shape of lateral processes but with very broad aedeagus in ventral view and a truncate dorsal spine. Length 3 mm.

External characters.—Vertex roundedly produced, yellowish in color with some greenish areas and a very faint median line. Pronotum and scutellum yellowish-green with a median whitish spot on anterior margin of pronotum. Wings subhyaline with a tinge of yellowish-green. Female last ventral segment roundedly produced.

Internal male genitalia.—Lateral processes in ventral view, short, stout, curving inwardly to tapered pointed tips which are bent and directed outward. Aedeagus very broad at apex in ventral view and medially notched. In lateral view the apex is enlarged and rounded with an anterior projecting piece near base of bulbous portion which connects to dorsal spine. Dorsal spine broad at base and narrowed slightly to a truncated ventrally directed apex.

Holotype male, allotype female, and male and female paratypes from Cordoba, V. C. Mexico, 10–8–41, collected by DeLong, Good, Caldwell and Plummer. Also three male paratypes from Carapan, Mich., Mexico, (432 Km.) 10–2–41, collected by the same men and one male paratype from Vera Cruz, Mexico, Aug. 1934, collected by Dr. A. Dampf. Types in the authors' collections.

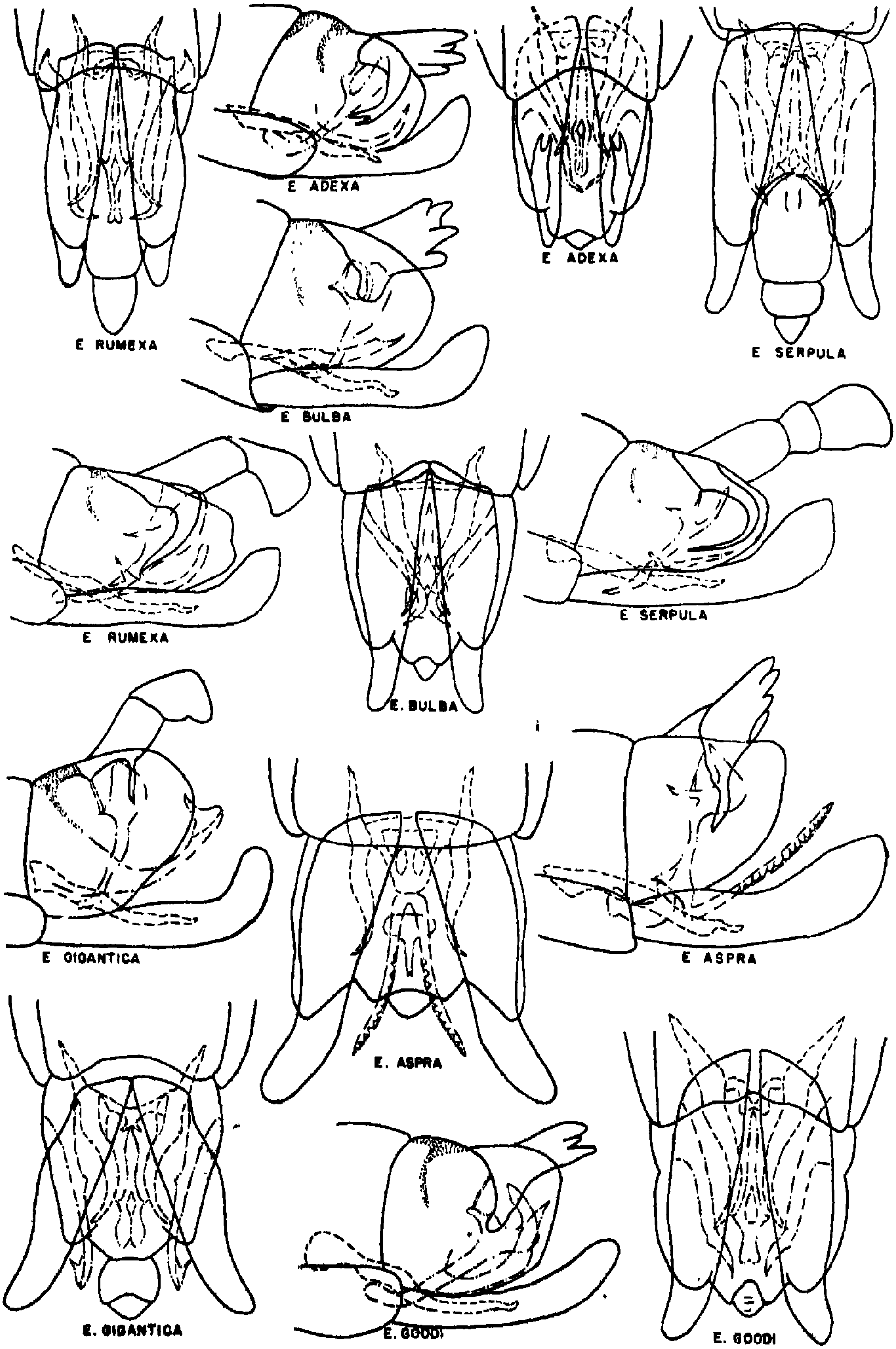
Empoasca aspra n. sp.

Resembling *ponderosa* in shape of dorsal spine, but a much larger species with heavier processes on the aedeagus. Length 4.5 mm.

External characters.—Frons, clypeus, vertex, pronotum and scutellum yellow-green. Vertex slightly produced with a faint median line. Pronotum with a whitish spot on anterior margin, subhyaline in central area and posterior margin. Wings milky to subhyaline. Female last ventral segment roundedly produced.

Ralph H. Davidson and Dwight M. DeLong
New Species of Empoasca

PLATE II



E RUMEXA
E ADEXA
E BULBA
E ADEXA
E SERPULA
E RUMEXA
E. BULBA
E SERPULA
E GIGANTICA
E. ASPRA
E ASPRA
E. GIGANTICA
E. GOODI
E. GOODI

Ventral and lateral views of the posterior end of the abdomen showing the internal pieces of the male genital chamber.

Internal male genitalia.—Base of aedeagus with a pair of long processes extending dorsally and caudally. These are much heavier than those found in *ponderosa* but very similar to those of *coccinea*. Apical portion in side view, with a broad posteriorly directed piece that curves sharply and tapers abruptly to a dorsally pointed tip. Upper part of aedeagus attached to the base of the dorsal spine which is ventrally directed and dagger-shaped except for a shallow notch on the anterior margin. Bending at the notch causes the tip to curve slightly anteriorly.

Holotype male, allotype female, and a large series of male and female paratypes from Rio Frio, D. F. Mexico, (55 Km.) collected by DeLong, Good, Plummer, and Caldwell on 10–7–41, and a pair of paratypes from Acapulco Road, Mexico, 11–22–38, collected by J. S. Caldwell. Types deposited in the authors' collections.

Empoasca gigantica n. sp.

A very large species which resembles *dactylata* in shape of lateral processes but with characteristic dorsal spine and coloration. Length 5–5.5 mm.

External characters.—Coloration somewhat variable in degree and intensity, the males showing the deeper tones. Frons and clypeus of males usually black which extends to margin of vertex. From dorsal aspect this coloration appears as three black spots, one median and two lateral next each eye. Remainder of vertex greenish-yellow with a faint black median line and a green spot on each side. Pronotum greenish-yellow anteriorly, becoming darker centrally and posteriorly. Three darkened stripes often present on scutellum. Wings milky to hyaline with brown spotting. Females have similar coloration except for yellow frons and clypeus and three black dots on margin of vertex. Female last ventral segment roundedly produced.

Internal male genitalia.—Lateral processes in lateral view, long, curved slightly upward, with a dorsally projecting process just before the rounded apex. Aedeagus much broadened apically in lateral view. Dorsal spine quite small and narrowed to a ventrally projecting tip.

Holotype male, allotype female, and a large series of male and female paratypes from Rio Frio, D. F. Mexico (55 Km.) collected by DeLong, Good, Caldwell, and Plummer on 10–7–41, and Mt. Popo, Mexico, 9–28–41, collected by the same men. Types deposited in the authors' collections.

Empoasca goodi n. sp.

A large species, resembling *gigantica* in size and coloration, but with distinctly different dorsal spine and lateral processes. Length 5 mm.

External characters.—Frons and clypeus of males usually brown to black colored. This extends to the margin of the vertex which appears from dorsal view as three black dots, one median and two lateral, which are next to the eyes. Remainder of the vertex greenish-yellow with a very faint median line. Pronotum yellowish anteriorly, becoming darker centrally and posteriorly. Scutellum yellow in color. Wings hyaline with faint yellow striping and smoky apices. Females similar in color except for yellow frons and clypeus and three black dots on margin of vertex. Female last ventral segment almost truncate with a median notch.

Internal male genitalia.—In lateral view, the lateral processes are directed posteriorly for one half their length, becoming broadened at this point and bending upward and tapering to pointed tips. Aedeagus in lateral view, enlarged near the apex into a hook-like process which is directed upward and slightly anteriorly. Dorsal spine broad at base and gradually narrowed to a rounded apex which is directed ventrad.

Holotype male, allotype female, and a large series of male and female paratypes from Carapan, Mich., Mexico (432 Km.) 10–2–41, all collected by Drs. D. M. DeLong, J. S. Caldwell, C. C. Plummer and Mr. E. E. Good. Other paratypes from Mexico City, D. F. 9–18–39, collected by DeLong; and Rio Frio, D. F. Mexico, 10–7–41, collected by the above named men. Types deposited in the authors' collections.

The authors take pleasure in naming this species after Mr. E. E. Good who has collected many interesting species of Cicadellidae.

PROTOZOAN PARASITES OF THE ORTHOPTERA, WITH SPECIAL REFERENCE TO THOSE OF OHIO

IV.[1] CLASSIFIED LIST OF THE PROTOZOAN PARASITES OF THE ORTHOPTERA OF THE WORLD. CLASSES MASTIGOPHORA, SARCODINA, AND SPOROZOA

FRANK MERRICK SEMANS
The Ohio State University
and
Youngstown College

This classified list of all protozoan parasites thus far reported for Orthoptera has been assembled for the purpose of making available from one source much information which formerly has been obtainable only by consulting and comparing a large number of books and papers.[2]

Beginning with class, and continuing down through genus, a short, characterizing description is given for each group. That these descriptions are mutually exclusive will be seen by comparing two groups of the same level, i.e., two classes, two orders, etc.

Under species, certain symbols have been used to relate the data under the various headings. Each reference is numbered and this is the number which is used to refer to that author under the other headings for that species. For example, a synonym followed by (1) indicates that author number (1), above, used that name for the parasite. Further, each host is indicated by a letter and followed by one or more numbers. The numbers, of course, again refer to the authors who studied that host, and the letter is used to refer to the host in the following data. For example, under *Leptomonas blaberae*, the first parasite listed, we find under distribution "Catuche, Venezuela" followed by "(la)." This means that author (1) above (Tejera) found *L. blaberae* in host "a" (*Blabera* sp.) captured in Catuche, Venezuela. Where more authors, etc., are listed, the method is the same, the number always referring to the author and the letter to the host.

In the lists of references, only works of a monographic nature are cited. This excludes most texts and general works, unless they contain original work in addition to mere compilation. In every case, only the first page of a reference is given, unless it is discontinuous, in which case the separate pages are given.

In the host lists, only the accepted names are used.

For habitat, i.e., the region of the insect in which the parasite was found, only the accepted terminology is used. (References: Comstock, 1930; Imms, 1929.)

Frequently, some localities are omitted under the heading "distribution." This means that the author did not specifically state where his material was collected and where he did his work.

---

[1] Part I: Ohio Jour. Sci., 36: 315-320. 1936. Part II: Ohio Jour. Sci., 39: 157-181. 1939. Part III: Ohio Jour. Sci., 41: 457-464. 1941.

[2] A bibliography will be included in a continued paper to appear in the next issue of this Journal.

CLASSIFIED LIST

Class 1. MASTIGOPHORA Diesing, 1865.

Possess one or more flagella during the greater part of the life-history, and in the adult state always.

Order 1. PROTOMONADIDA Blochmann, 1895.

Possess few flagella (rarely more than 6), one nucleus, and are usually without accessory internal organs.

Family 1. *Trypanosomidae* Doflein, 1901.

Possess a single flagellum, and are parasitic in vertebrates, invertebrates, or plants.

Genus 1. **Leptomonas** Kent, 1880. Found only in invertebrate hosts, and never developing beyond the *Leptomonas* stage, showing only this and *Leishmania* forms in their life cycle.

Leptomonas blaberae Tejera, 1926.
References: (1) Tejera, 1926, 1382.
Synonymy: Name unchanged.
Hosts: (a) *Blabera* sp.
Habitat: ?
Distribution: Catuche, Venezuela (1a).

Leptomonas sp.
References: (1) This paper, parts II and III.
Hosts: (a) *Parcoblatta virginica* (Brunner); (b) *P. lata* (Brunner); (c) *P. pensylvanica* (DeGeer); all by (1).
Habitat: Hind-intestine, (1a), (1b), (1c).
Distribution: Franklin (1a), (1c); Fairfield (1b), (1c); Champaign (1c); Hocking (1b); Logan (1c); Madison (1c); and Washington (1c) Counties Ohio.

Genus 2. **Herpetomonas** Kent, 1880 Found only in invertebrate hosts, but showing *Leishmania*, *Leptomonas*, *Crithidia*, and *Trypanosoma* types in their cycles.

Herpetomonas periplanetae Laveran and Franchini, 1920.
References: (1) Laveran and Franchini, 1920a, 145; (2) Laveran and Franchini, 1920b, 331.
Synonymy: Name unchanged.
Hosts: (a) *Blatta orientalis* Linnaeus, (1), (2).
Habitat: Alimentary canal, (1a), (2a).
Distribution: Paris, France, (2a); Bologna, Italy, (1a).

Family 2. *Cryptobiidae* Poche, 1913.

Possess two flagella, one of which is directed forward, while the other passes backward and is attached to the surface of the body, and may be raised into an undulating membrane.

Genus 1. **Cryptobia** Leidy, 1846. Found in intestinal canal of fishes and seminal vesicles and spermatophores of molluscs and other invertebrates.

Cryptobia gryllotalpae (Hamburger, 1911).
References: (1) Hamburger, 1912, 216; (2) This paper, under synonymy.
Synonymy: *Trypanoplasma gryllotalpae* (1); *Cryptobia gryllotalpae* (2). (Genus *Cryptobia* Leidy substituted for *Trypanoplasma* Laveran and Mesnil. See Kudo, 1931, 147.)
Hosts (a) *Gryllotalpa gryllotalpa* Linnaeus (1).
Habitat: Hind-intestine, (1a).
Distribution: Heidelberg, Germany, (1a).

Family 3. *Bodonidae* Doflein, 1901.

Possess two flagella, one of which is directed backward as a trailing flagellum.

Genus 1. **Embadomonas** Mackinnon, 1911. Found in the intestine of mammals and insects.

Embadomonas blattae Bishop, 1931.
References: (1) Bishop, 1931, 287.
Synonymy: Name unchanged.
Hosts: (a) *Blatta orientalis* Linnaeus, (1).
Habitat: Hind-intestine, (1a).
Distribution: Cambridge, England, (1a).

Order 2. POLYMASTIGIDA Blochmann, 1884.

Possess three to eight flagella, one to many nuclei, and frequently axostyle or axial filament.

Tribe 1. *Monozoa* Calkins, 1926.

Possess one cytostome and kinetic element.

Genus 1. **Retortamonas** Grassi, 1879 Possess four flagella, one of which trails. Parasitic in the intestine of various insects.

Retortamonas gryllotalpae Grassi, 1879.
References: (1) Grassi, 1879, 448; (2) Grassi, 1881, 153, 161, et. al.; (3) Hamburger, 1912, 216.
Synonymy: *Retortamonas gri* (and *y*) *llotalpae*, (1), (2); *Schedoacercomonas melolonthae*, (1); *S. gri* (and *y*) *llotalpae*, (1); *Monocercomonas insectorum*, (2), (3); *Plagiomonas Gri* (and *y*) *llotalpae*, (2).
Hosts: (a) Larval gryllotalpae, (2).
Habitat: Hind-intestine, (2a).
Distribution: Rovellasca, Italy (?), (2a).

Retortamonas orthopterorum (Parisi, 1910) Wenyon, 1926.
References: (1) Parisi, 1910, 235; (2) Hamburger, 1912, 216; (3) Belar, 1916, 243; (4) Wenyon, 1926, 678; (5) Kudo, 1931, 159; (6) McAdow, 1931, 21; (7) Balch, 1932, 237.
Synonymy: *Trichomonas orthopterorum*, (1), (2); *Monocercomonas orthopterorum*, (3), (7); *Retortamonas orthopterorum*, (4), (5), (6).
Hosts: (a) *Ectobia lapponica* (Linnaeus), (1); (b) *Blatta orientalis* Linnaeus (1); (c) *Gryllotalpa gryllotalpa* Linnaeus, (1), (2). Also reported as *Monocercomonas orthopterorum* from *Tipula abdominalis*, a dipteran. (See Geiman, 1932, 173).
Habitat: Alimentary canal, (1c), (1a); Hind-intestine, (1a), (1b), (1c); rectum, (2c).
Distribution: Heidelberg, Germany, (2c); Lombardy, Italy, (1a), (1b), (1c); Trentino, Italy, (1b), Baden, (?), (1b).

Tribe 2. *Diplozoa* Calkins, 1926.

Possess two cytostomes and kinetic elements.

Genus 1. **Octomitus** Prowazek, 1904. Possess six anterior and two posterior flagella. Parasitic.

Octomitus periplanetae Belar, 1916.
References: (1) Belar, 1916, 254; (2) Kudo, 1931, 162; (3) McAdow, 1931, 21.
Synonymy: Name unchanged.
Hosts: (a) "Kitchen-cockroach," (1).
Habitat: Alimentary canal, (1a).
Distribution: Vienna, Austria, (1a).

Order 3. HYPERMASTIGIDA Grassi, 1911.

Possess numerous flagella, a single nucleus, and may have axostyles and parabasal bodies.

Family 1. *Lophomonadidae* Grassi, 1885.

Flagella arise from the anterior end in a tuft. Parasitic in cockroaches and termites.

Genus 1. **Lophomonas** Stein, 1860. Parasitic in the colon of cockroaches.

Lophomonas blattarum Stein, 1860.
References: (1) Stein, 1860, 49; (2) Butschli, 1878, 258; (3) Leidy, 1879, 204; (4) Kent, 1880–1882, 321; (5) Grassi, 1881, 172; (6) Schuster, 1898, 242; (7) Janicki, 1908, 141; (8) Janicki, 1910, 244; (9) Belar, 1916, 242; (10) Kudo, 1922, 113; (11) Kudo, 1926a, 191; (12) Kudo, 1926c, 504; (13) McAdow, 1931, 15.
Synonymy: *Lophomonas Blattarum*, (1), (5); *Lophomonas blattarum*, (2), (3), (4), (6), (7), (8), (9), (10), (11), (12), (13).
Hosts: (a) *Blatta orientalis* Linnaeus, (1), (2), (7), (8), (10), (11), (12); (b) *Blatta* sp. (5); (c) *Periplaneta americana* (Linnaeus), (6); (d) *Gryllotalpa* sp., (8).
Habitat: Hind-intestine, (2a), (7a), (8a), (8d); colon, (6c), (13?); rectum, (1a), (13?).
Distribution: Europe, (8a), (8d); Germany, (2a); Rome, Italy, (7a); Rovellasca, Italy ?, (5b); Urbana, Illinois, (10a), (11a), (12a); Ohio, (13?).

Lophomonas striata Bütschli, 1878.
References: (1) Bütschli, 1878, 258; (2) Kent, 1880–1882, 322; (3) Grassi, 1881, 177; (4) Schuster, 1898, 243; (5) Janicki, 1908, 144; (6) Janicki, 1910, 244; (7) Belar, 1916, 242; (8) Kudo, 1922, 113; (9) Yakimoff and Miller, 1922a, 9; (10) Yakimoff and Miller, 1922b, 133; (11) Kudo, 1926c, 504; (12) Tejera, 1926, 1382; (13) Lucas, 1928, 172; (14) Weill, 1929, 22; (15) McAdow, 1931, 15.

Synonymy: *Lophomonas striata*, (1), (2), (5), (6), (7), (8), (9), (10), (11), (12), (13), (14), (15); *Lophomonas Striata*, (3); *Lophomonas sulcata*, (4). (*L. sulcata* was distinguished by Schuster from *L. striata* chiefly on the basis of the greater size of the former. Kudo (1926c, 505) intimates that the size and characteristics described for *L. sulcata* are comprehended by those of *L. striata*.)

Hosts: (a) *Blatta orientalis* Linnaeus, (1), (5), (6), (8), (11); (b) *Periplaneta americana* (Linnaeus), (4), (14); (c) *Gryllotalpa* sp., (6).

Habitat: Alimentary canal, (4b), (13?); hind-intestine, (1a), (5a), (6a), (6c), (14b); colon and rectum, (15?).

Distribution: Europe, (6a), (6c); Germany, (1a); Rome, Italy, (5a); French Indo-China, (14b); Urbana, Illinois, (8a), (11a); Ohio, (15?).

Class 2. SARCODINA Hertwig and Lesser, 1874.

Capable of changing the body form and forming pseudopodia, both for locomotion and food-capturing.

Order 1. AMOEBIDA Calkins, 1902.

Body unprotected by any shell or skeletal structure. Cytoplasm differentiated into endo- and ectoplasm.

Family 1. *Endamoebidae* Calkins, 1926.

Endoparasitic, with wide zoological distribution.

Genus 1. **Endamoeba** Leidy, 1879. Nucleus spherical or oblong with very thick membrane. Several endosomes. Parasitic in invertebrates.

Endamoeba blattae (Bütschli, 1878) Leidy, 1879.

References: (1) Bütschli, 1878, 273; (2) Leidy, 1879, 204; (3) Grassi, 1881, 184; (4) Schubotz, 1905, 6; (5) Mercier, 1907, 1182; (6) Janicki, 1908, 148; (7) Mercier, 1908b, 943; (8) Elmassian, 1909, 144; (9) Janicki, 1909, 381; (10) Mercier, 1909, 164; (11) Mercier, 1910, 143; (12) Belar, 1916, 242; (13) Kudo, 1922, 113; (14) Yakimoff and Miller, 1922b, 133; (15) Kudo, 1926b, 139; (16) Kudo, 1926c, 505; (17) Thompson and Lucas, 1926, 41; (18) Lucas, 1927a, 220; (19) Lucas, 1928, 161 and 171; (20) McAdow, 1931, 13; (21) Balch, 1932, 237.

Synonymy: *Amoeba blattae*, (1), (2), (4), (5), (6), (7), (8), (10); *Endamoeba blattae*, (2), (13), (15), (16), (17), (18), (19), (20), (21); *Amoeba Blattae*, (3); *Entamoeba blattae*, (9), (11), (12), (14). Yakimoff and Miller (1922a) and Tejera (1926) mention an *Entamoeba battarum* in "*Periplaneta orientalis*" and "Blattes," respectively; later corrected by Yakimoff (1922b) and changed to *Entamoeba blattae*. For the same hosts, they give a *Monas* sp. (origin?), Yakimoff and Miller including *Lophomonas blattae* (doubtless *L. blattarum* Stein, 1860) and *Oicomonas* sp. (origin?), and Tejera includes *Oikomonas blattarum* (origin?) and *Plagiostoma blattarum* (undoubtedly *Plagiotoma blattarum* Stein, 1859, now *Nyctotherus ovalis* Leidy, 1850.)

Hosts: (a) *Blatta orientalis* Linnaeus, (1), (4), (5), (6), (9), (10), (11), (13), (15), (17), (19), (20); (b) *Periplaneta americana* (Linnaeus), (19).

Habitat: Alimentary canal, (10a); hind-intestine, (1a), (4a), (5a), (6a), (9a), (11a), (17a); colon, (15a), (20a); rectum, (20a).

Distribution: London, England, (19a); France, (5a), (10a), (11a); Germany, (1a), (4a); Rome, Italy, (6a), (9a); Rovellasca, Italy (?), (3?); Urbana, Illinois, (13a), Baltimore, Maryland, (19b); Ohio, (20a).

Endamoeba thomsoni Lucas, 1927.

References: (1) Lucas, 1927b, 224; (2) Lucas, 1928, 173; (3) Smith and Barret, 1928, 272; (4) Taliaferro, 1928, 274; (5) McAdow, 1931, 14; (6) Balch, 1932, 237.

Synonymy: *Entamoeba thomsoni*, (1), (2), (4), (5); *Endamoeba thomsoni*, (3), (6).

Hosts: (a) *Blattella germanica* (Linnaeus), (5); (b) *Blatta orientalis* Linnaeus, (5); (c) *Periplaneta americana* (Linnaeus), (1), (3), (5).

Habitat: Hind-intestine, (3c); colon and rectum, (5a), (5b), (5c).

Distribution: England, (1c); Charlotte, North Carolina, (3c); Ohio, (5a), (5b), (5c).

Genus 2. **Entamoeba** Casagrandi and Barbagallo, 1895. Nucleus vesicular, membrane thin but distinct. Small endosome. Numerous species in man, mammals and invertebrates.

Entamoeba nana Tejera, 1926.

References: (1) Tejera, 1926, 1382.

Synonymy: Name unchanged.

Hosts: (a) *Blaberus atropos* (Stoll), (1).

Habitat: Alimentary canal, (1a).

Distribution: Venezuela, (1a).

Genus 3. **Endolimax** Kuenen and Swellengrebel, 1917. Nucleus with definite membrane; large, irregular endosome. Small parasitic amoebae.

Endolimax blattae Lucas, 1927.
References: (1) Lucas, 1927a, 220; (2) Lucas, 1927b, 229; (3) Weill, 1929, 23; (4) McAdow, 1931, 21.
Synonymy: Name unchanged.
Hosts: (a) *Blatta orientalis* Linnaeus, (2); (b) *Periplaneta americana* (Linnaeus), (2), (3).
Habitat: Hind-intestine, (2a), (2b); rectum, (3b).
Distribution: England, (2a), (2b); French Indo-China, (3b).

Class 3. SPOROZOA Leuckart, 1879.

Possess no cilia or flagella. Occasionally move about by pseudopodia when immature, but nutrition is by absorption only. Usually non-motile and reproducing by spores.

Subclass 1. TELOSPORIDIA Schaudinn, 1900.

Spores have neither polar capsule nor polar filament. Spore formed at the end of the trophic life and contains one to several sporozoites.

ORDER 1. GREGARINIDA Bütschli, 1882.

Coelozoic parasites in invertebrates. The vast majority do not undergo schizogony.

Tribe 1. *Acephalinidea* Kölliker, 1848.

Body an unsegmented mass of cytoplasm.

Family 1. *Diplocystidae* Bhatia, 1930.

Spores spherical or oval, with eight sporozoites.

Genus 1. **Diplocystis** Kunstler, 1887. (Not Penard, 1890. See Cuénot, 1897b.)
Trophozoites fuse precociously to form spherical masses. Coelomic.

Diplocystis schneideri Kunstler, 1887.
References: (1) Kunstler, 1887, 25; (2) Léger, 1892, 45; (3) Labbé, 1899, 46; (4) Magalhães, 1900, 44; (5) Cuénot, 1901, 598; (6) Léger and Duboscq, 1902b, 384; (7) Lühe, 1904, 113, 139; (8) Woodcock, 1904, 127; (9) Schiffman, 1919, 81; (10) Jameson, 1920, 207; (11) Bhatia, 1930, 161.
Synonymy: *Diplocystis schneideri*, (1), (3), (4), (5), (7), (9), (10), (11); *Diplocystis Schneideri*, (2), (6), (8).
Hosts: (a) *Blatta orientalis* Linnaeus, (8), (10); (b) *Periplaneta americana* (Linnaeus), (1), (10).
Habitat: Coelom, (1b), (10a), (10b); posterior mid-intestinal wall, (10a), (10b).
Distribution: London, England, (10a), (10b); France, (1b).

Diplocystis major Cuénot, 1897.
References: (1) Cuénot, 1894, 806; (2) Cuénot, 1895, 321; (3) Cuénot, 1897a, 54; (4) Labbé 1899, 46; (5) Léger and Duboscq, 1900, 1567; (6) Caullery and Mesnil, 1901, 84; (7) Cuénot, 1901, 595; (8) Léger and Duboscq, 1901, 439; (9) Léger and Duboscq, 1902a, 41; (10) Léger and Duboscq, 1902b, 384, 452; (11) Luhe, 1904, 93, 96, 113, 139, 161; (12) Woodcock, 1904, 127; (13) Dogiel, 1909, 201, 206; (14) Wellmer, 1910, 532; (15) Wellmer, 1911, 144.
Synonymy: *Diplocystis* sp., (1); *Diplocystis major*, (2), (3), (4), (5), (6), (7), (8), (9), (10,) (11), (12), (13), (14), (15).
Hosts: (a) *Gryllus domesticus* Linnaeus, (1), (2), (3), (7), (9), (14), (15).
Habitat: Coelom, (1a), (2a), (3a), (7a), (9a), (15a), (8?).
Distribution: East Prussia, (14a), (15a); Altkirch and Roscoff, France, (7a); Ardennes, France, (2a), (3a); Haute-Loire, France, (7a); Joinville and Nancy, France, (3a), (7a).

Diplocystis minor Cuénot, 1897.
References: (1) Cuénot, 1897a, 54; (2) Labbé, 1899, 46; (3) Cuénot, 1901, 595; (4) Léger and Duboscq, 1902b, 385; (5) Lühe, 1904, 113; (6) Woodcock, 1904, 127; (7) Dogiel, 1909, 206.
Synonymy: Name unchanged.
Hosts: (a) *Gryllus domesticus* Linnaeus, (1), (3).
Habitat: Coelom, (1a), (3a).
Distribution: Beauvais and Chauny, France, (1a), (3a); Sauville, Villerle-Tilleul, Vendresse, and Nancy, France, (3a).

Tribe 2. *Cephalinidea* Delage, 1896.

Body divided into two portions by a septum of the ectoplasm.

Family 1. *Gregarinidae* Labbé, 1899.

Associative or solitary; satellite with septum. Epimerite symmetrical, simple. (In the opinion of the author, the mere observation of cyst development and dehiscence does not give conclusive evidence as to the identity of an adult found in the same habitat, unless cyst formation is observed, which is rarely the case. Unless the latter phenomenon has been observed, cyst characters are disregarded in the description of new species of Gregarinidae, and they are classified as far as possible on the basis of adult characteristics, comparing them with previously named species. In order to make possible a more accurate classification of Gregarinidae than now exists, it will be necessary to determine methods of culturing species of gregarines so as to obtain them in large numbers, and to perfect a technique for bringing about cyst formation under observation.)

Genus 1. **Leidyana** Watson, 1915. Solitary. Epimerite a simple, globular, sessile knob. Dehiscence by spore ducts. Spores barrel-shaped, in chains.

Leidyana gryllorum (Cuénot, 1897) Watson, 1916.
References: (1) Cuénot, 1897a, 54; (2) Labbé, 1899, 10; (3) Cuénot, 1901, 594; (4) Watson, 1916a, 120; (5) Bhatia and Setna, 1924, 288; (6) This paper, parts II and III.
Synonymy: *Clepsidrina gryllorum*, (1); *Gregarina macrocephala*, (2); *Gregarina gryllorum*, (3); *Leidyana gryllorum*, (4), (5), (6).
Hosts: (a) *Gryllus assimilis* Fabricius, (6); (b) *Gryllus domesticus* Linnaeus, (1), (2), (3); (c) *Gryllus* spp., (5); (d) *Nemobius sylvestris* (Bosc d'Antic), (2); (e) *Nemobius fasciatus fasciatus* (DeGeer), (6).
Habitat: Alimentary canal, (1b), (2b), (2d); gizzard and mid-intestine, (5c); enteric ceca and mid-intestine, (6e); mid-intestine, (3b), (6a).
Distribution: Ardennes, France, (2b), (2d), (1b), (3b); Nancy, Joinville, and Roscoff, France, (3b); Lahore, India, (5c); Franklin and Washington Counties, Ohio, (6a), (6e).

Leidyana erratica (Crawley, 1907) Watson, 1916.
References: (1) Crawley, 1903a, 45; (2) Crawley, 1903b, 639, 641; (3) Crawley, 1907, 221; (4) Ellis, 1913c, 286; (5) Watson, 1915, 35; (6) Watson, 1916a, 118; (7) Kamm, 1922a, 133; (8) Bhatia and Setna, 1924, 288; (9) This paper, parts II and III.
Synonymy: *Gregarina achetaeabbreviatae*, (1), (2); *Stephanophora erratica*, (3), (4); *Leidyana solitaria*, (5); *Leidyana erratica*, (6), (7), (8), (9).
Hosts: (a) *Gryllus assimilis* Fabricius, (3), (5), (6), (9); (b) *Gryllus* spp., (8); (c) *Nemobius fasciatus fasciatus* (DeGeer), (9); (d) *Nemobius fasciatus socius* Scudder, (9); (e) *Anaxipha exigua* (Say), (9); (f) *Hapithus agitator agitator* Uhler, (9).
Habitat: Alimentary canal, (6a); gizzard, (8b); enteric ceca, (9c), (6a); mid-intestine, (8b), (9a), (9c), (9d), (9e), (9f).
Distribution: Lahore, India, (8b); Beach Haven, New Jersey, (3a); Cold Spring Harbor and Oyster Bay, New York, (6a); Champaign County, Ohio, (9d); Franklin County, Ohio, (9a); Delaware County, Ohio, (9e); Washington County, Ohio, (9a), (9c), (9e), (9f).

Genus 2. **Gregarinoides** Fantham, 1925. Biassociative. Epimerite small, globular, or cylindric. Dehiscence by simple rupture.

Gregarinoides locustanae Fantham, 1925.
References: (1) Fantham, 1923, 495; (2) Fantham, 1924, 438; (3) Fantham, 1925, 351; (4) Bush, 1928, 157, et. al.
Synonymy: Reference, but name not used, (1), (2); *Gregarinoides locustanae*, (3), (4).
Hosts: (a) *Locustana pardalina* (F. Walker), (1), (3); (b) 35 ? species of "Acridiidae" common to Natal, South Africa, (4).
Habitat: Mid-intestine, (1a), (3a).
Distribution: Pietermaritzburg, Natal, (4b); Johannesburg, Transvaal, (1a), (3a).

Genus 3. **Gregarina** Dufour, 1828. (*Often incorrectly given as 1826.*) Biassociative. Epimerite small, globular or cylindric. Dehiscence by spore ducts. Spores barrel-shaped to cylindric.

This classification is based, in part, on the presence of these gregarines in hosts of common classification, i. e., hosts of the same family, etc. This is justifiable inasmuch as these groups of protozoan parasites from related hosts present certain marked resemblances, whether through adaptation or common ancestry.

Division 1. *Actinocephalus*-like sporonts. Hosts, Gryllidae, etc.

Gregarina hyalocephala Dufour, 1837.
References: (1) Dufour, 1837, 13; (2) Siebold, 1839, 70; (3) Frantzius, 1846; (4) Diesing, 1851, 11; (5) Diesing, 1859, 731; (6) Lankester, 1863, 94; (7) Labbé, 1899, 34; (8) Watson, 1916a, 97, 214.
Synonymy: Name unchanged.
Hosts: (a) *Tridactylus variegatus* (Latreille), (1); (b) *Tridactylus* spp., (1).
Habitat: Mid-intestine, (1a), (1b).
Distribution: France, (1a), (1b).

Gregarina conica Dufour, 1837.
References: (1) Dufour, 1837, 12; (2) Siebold, 1839, 70; (3) Desmarest, 1845, 317; (4) Frantzius, ?; (5) Diesing, 1851, 8; (6) Diesing, 1859, 729; (7) Lankester, 1863, 95; (8) Watson, 1916a, 125.
Synonymy: Name unchanged.
Hosts: (a) Gryllidae, spp., (1).
Habitat: Mid-intestine, (1a).
Distribution: France, (1a).

Gregarina oblonga Dufour, 1837.
References: (1) Dufour, 1837, 13; (2) Frantzius, 1846; (3) Frantzius, 1848, 195; (4) Diesing, 1851, 11; (5) Diesing, 1859, 732; (6) Lankester, 1863, 94; (7) Watson, 1916a, 96.
Synonymy: Name unchanged.
Hosts: (a) *Locusta migratoria* Linnaeus, (1); (b) *Acheta campestris* (Linnaeus), (1).
Habitat: Mid-intestine, (1a), (1b).
Distribution: France, (1a), (1b).

Division 2. Gregarine more or less cylindric.

Subdivision 1. Hosts, Blattidae.

Group 1. Gregarine tenuous.

Gregarina panchlorae Frenzel, 1892. Possibly there is a close relationship between this species and *Protomagalhaensia serpentula*.)
References: (1) Frenzel, 1892, 299; (2) Wasielewski, 1896, 138; (3) Labbé 1899, 35; (4) Ellis, 1913c, 265; (5) Watson, 1916a, 103.
Synonymy: Name unchanged.
Hosts: (a) *Panchlora exoleta* Burmeister, (1).
Habitat: Mid-intestine, (1a).
Distribution: Cordoba, Argentina, (1a).

Group 2. Gregarine thick.

Gregarina ohioensis Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Parcoblatta virginica* (Brunner), (1).
Habitat: Mid-intestine, (1a).
Distribution: Franklin County, Ohio, (1a).

Gregarina thomasi Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Parcoblatta pensylvanica* (DeGeer), (1).
Habitat: Enteric ceca and mid-intestine, (1a).
Distribution: Fairfield County, Ohio (1a).

Gregarina illinensis Watson, 1915.
References: (1) Watson, 1915, 34; (2) Watson, 1916a, 108; (3) Kamm, 1922a, 131; (4) Kamm, 1922b, 84; (5) this paper, part II.
Synonymy: Name unchanged.
Hosts: (a) *Parcoblatta pensylvanica* (DeGeer), (1).
Habitat: Alimentary canal, (1a).
Distribution: Urbana, Illinois, (1a).

Gregarina parcoblattae Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Parcoblatta uhleriana* (Saussure), (1); (b) *Parcoblatta pensylvanica* (DeGeer), (1).
Habitat: Mid-intestine, (1a), (1b).
Distribution: Fairfield County, Ohio, (1a), (1b); Franklin County, Ohio, (1b); Washington County, Ohio, (1a).

Gregarina blattarum Siebold, 1839. (*G. blattarum* described by Watson, 1916b, 73, appears to be a variation of that described in Europe, and is referred to elsewhere as "Watson variety" as contrasted with "Old World variety.")
References: (1) Siebold, 1837, 408; (2) Siebold, 1839, 67; (3) Dujardin, 1845, 638; (4) Frantzius, 1846; (5) Frantzius, 1848, 193, 195; (6) Stein, 1848, 223; (7) Diesing, 1851, 10; (8) Leidy, 1853a, 239; (9) Leidy, 1856, 47; (10) Diesing, 1859, 731; (11) Lankester, 1863, 85, 94; (12) Schneider, 1876, 92, etc.; (13) Bütschli, 1881, 385; (14) Schneider, 1882, 424, 442; (15) Balbiani, 1884, 13, 68, 170; (16) Kunstler, 1887, 32, 53; (17) Schneider, 1887, 74, 75; (18) Wolters, 1891, 102, 107, 115, 128, 131; (19) Léger, 1892, 45, 75, 93; (20) Marshall, 1893, 25; (21) Pfeiffer, 1893, 4, 132; (22) Schewiakoff, 1894, 342; (23) Wasielewski, 1896, 34, 136; (24) Schuster, 1898, 244; (25) Labbé, 1899, 35; (26) Magalhães, 1900, 38; (27) Caullery and Mesnil, 1901, 84; (28) Cuénot, 1901, 619; (29) Léger and Duboscq, 1901, 441; (30) Léger and Duboscq, 1902b, 421, 428; (31) Crawley, 1903a, 44; (32) Crawley, 1903b, 639; (33) Lühe, 1904, 118, 134, 139, 172; (34) Hall, 1907, 149, 151, etc.; (35) Léger and Duboscq, 1909, 88, 98; (36) Wellmer, 1910, 531; (37) Wellmer,

1911, 106, 113; (38) Ellis, 1913b, 83; (39) Ellis 1913c, 265; (40) Belar, 1916, 242; (41) Watson, 1916a, 99; (42) Watson, 1916b, 73; (43) Pinto, 1918b, 322; (44) Schiffman, 1919, 79; (45) Laveran and Franchini, 1920b, 332; (46) Kudo, 1922, 113; (47) Tejera, 1926, 1382; (48) Fantham, 1929, 389; (49) McAdow, 1931, 11; (50) this paper, part II.

Synonymy: *Gregarina* sp., (1); ***Gregarina blattarum***, (2), (3), (4), (6), (13), (20), (24), (25), (28), (29), (31), (32), (33), (34), (35), (36), (37), (38), (39), (40), (41), (42), (43), (44), (45), (46), (47), (48), (49), (50); ***Gregarina Blattarum***, (5), (7,) (9), (10), (11), (15); ***Gregarina Blattae orientalis***, (8); ***Clepsidrina Blattarum***, (12), (15), (17), (18); ***Clepsidrina blattarum***, (14), (15), (16), (19), (21), (22), (23), (26), (27), (30); *Gregarina blattae orientalis*, (25).

Hosts: (a) *Parcoblatta pensylvanica* (DeGeer), (14); (b) ***Blattella germanica*** (Linnaeus), (31), (41); (c) *Blatta orientalis* Linnaeus, (2), (8), (12), (20), (22), (26), (28), (31), (36), (37), (42), (45), (49); (d) *Periplaneta americana* (Linnaeus), (24), (31), (34), (41), (49).

Habitat: Coelom, (26c); alimentary canal, (2c), (8c), (12c), (20c), (31b), (31c), (31d), (42c), (45c); enteric ceca, (26c), (49c), (49d); mid-intestine, (26c), (28c), (49c), (49d).

Distribution: Brazil, (26c); France, (12)c, (28c), (45c); East Prussia, (36c); Königsberg, Germany, (37c); Urbana, Illinois, (42c); Douglas Lake, Michigan, (38a); Raleigh, North Carolina, (31b), (31c), (31d); Ohio, (49c), (49d); Wyncote, Pennsylvania, (31b), (31c), (31d).

Subdivision 2. Hosts, Acrididae.

Gregarina rigida columna Semans, 1939.

References: (1) This paper, parts II and III.

Hosts: (a) ***Arphia sulphurea*** (Fabricius), (1); (b) ***Chortophaga viridifasciata*** (DeGeer), (1); (c) ***Encoptolophus sordidus*** (Burmeister), (1); (d) *Pardalophora apiculata* (Harris), (1); (e) ***Dissosteira carolina*** (Linnaeus), (1); (f) ***Spharagemon bolli*** Scudder, (1); (g) ***S. collare collare*** (Scudder), (1); (h) ***Melanoplus obovatipennis*** (Blatchley), (1); (i) ***M. scudderi scudderi*** (Uhler), (1); (j) ***M. differentialis*** (Thomas), (1); (k) ***M. bivittatus*** (Say), (1); (l) ***M. mexicanus mexicanus*** (Saussure), (1); (m) ***M. keeleri luridus*** (Dodge), (1).

Habitat: Base of enteric ceca, (1f), (1h), (1m); enteric ceca and mid-intestine, (1a), (1b), (1c), (1d), (1e), (1g), (1i), (1j), (1k), (1l), (1m).

Distribution: Gary, Indiana, (1g), (1j), (1k); Fairfield County, Ohio, (1a), (1b), (1d), (1i), (1k), (1l), (1m); Franklin County, Ohio, (1c), (1b); Licking County, Ohio, (1e), (1f), (1h), (1m); Union County, Ohio, (1j).

Gregarina rigida rigida (Hall, 1907) Ellis, 1913.

References: (1) Hall, 1907, 150, 169, etc.; (2) Crawley, 1907, 223; (3) Sokolow, 1911, 279; (4) Wellmer, 1911, 108; (5) Ellis, 1913a, 464; (6) Ellis, 1913b, 82; (7) Ellis, 1913c, 267; (8) Watson, 1915, 34; (9) Watson, 1916a, 105; (10) Kamm, 1920, 23; (11) this paper, parts II and III.

Synonymy: *Hirmocystis rigida* (1), (3), (4), (5); ***Gregarina melanopli***, (2), (3), (6); ***Gregarina*** *rigida*, (7), (8), (9), (10); *Gregarina rigida rigida*, (11).

Hosts: (a) *Chorthippus curtipennis curtipennis* (Harris), (11); (b) ***Arphia sulphurea*** (Fabricius), (11); (c) ***Encoptolophus sordidus*** (Burmeister)?, (9); (d) ***Dissosteira carolina*** (Linnaeus), (11); (e) *Spharagemon bolli* Scudder, (11); (f) ***Brachystola magna*** (Girard), (5), (7); (g) *Schistocerca americana americana* (Drury)?, (9); (h) ***Hesperotettix viridis praetensis*** (Scudder)?, (9); (i) ***Melanoplus*** *obovatipennis* (Blatchley), (11); (j) ***M. differentialis*** (Thomas), (1), (9?), (11); (k) ***M. bivittatus*** (Say), (1), (2), (6), (9?), (11); (l) *M. femur-rubrum femur-rubrum* (DeGeer), (6), (9), (11); (m) ***M. mexicanus mexicanus*** (Saussure), (9?), (11); (n) ***M. keeleri luridus*** (Dodge), (6), (9?), (11); (o) ***M. angustipennis*** (Dodge), (1), (9?).

Habitat: Alimentary canal, (1j), (1k), (1o); gizzard, (11l); base of ceca, (11i), (11n); enteric ceca, (11a), (11c), (11d), (11j), (11k), (11l), (11m), (9?); mid-intestine, (11a), (11b), (11c), (11d), (11e), (11g), (11l), (11m), (11n).

Distribution: Canon City, Colorado, (1j), (1k), (1o); Colorado Springs, Colorado, (9?); Urbana, Illinois, (9?); Gary, Indiana, (11a), (11d), (11k), (11m); Douglas Lake, Michigan, (6k), (6l), (6n); Lincoln, Nebraska, (9?); Oyster Bay, New York, (9?); Fairfield County, Ohio, (11b), (11e), (11k), (11m), (11n); Franklin County, Ohio, (11c), (11d), (11j), (11l), (11n); Licking County, Ohio, (11i), (11n); Washington County, Ohio, (11j), (11l); Wyncote, Pennsylvania, (2k).

Gregarina indianensis Semans, 1939.

References: (1) This paper, parts II and III.

Hosts: (a) *Chorthippus curtipennis curtipennis* (Harris), (1); (b) ***Melanoplus differentialis*** (Thomas), (1); (c) *M. bivittatus* (Say), (1); (d) ***M. mexicanus mexicanus*** (Saussure), (1).

Habitat: Enteric ceca, (1a), (1b), (1c), (1d); mid-intestine, (1a), (1b), (1c), (1d).

Distribution: Gary, Indiana, (1a), (1b), (1c), (1d).

Gregarina nigra Watson, 1915.

References: (1) Watson, 1915, 33; (2) Watson, 1916a, 116; (3) Kamm, 1922a, 130; (4) Kamm, 1922b, 84; (5) Bush, 1928, 154, et. al.; (6) this paper, part II.

Synonymy: Name unchanged.

Hosts: (a) ***Encoptolophus sordidus*** (Burmeister), (1); (b) ***Zonocerus elegans*** (Thunberg), (5); (c) ***Lentula*** sp., (5); (d) *Cyrtacanthacris ruficornis* (Fabricius), (5); (e) ***Melanoplus differentialis*** (Thomas), (3), (4); (f) ***M. femur-rubrum femur-rubrum*** (DeGeer), (1), (6).

Habitat: Alimentary canal, (5b), (5c), (5d); mid-intestine, (6f).

Distribution: Pietermaritzburg, Natal, (5b), (5c), (5d); Urbana, Illinois, (1a), (1f), (3e), (4e); Washington County, Ohio, (6f).

Gregarina locustae Lankester, 1863.
References: (1) Leidy, 1853a, 239; (2) Leidy, 1856, 47; (3) Diesing, 1859, 730; (4) Lankester, 1863, 94; (5) Léger, 1897, 10; (6) Labbé, 1899, 35; (7) Crawley, 1903a, 54; (8) Crawley, 1903b, 640; (9) Crawley, 1907, 225; (10) Ellis, 1913c, 268; (11) Watson, 1916a, 100; (12) this paper, parts II and III.
Synonymy: *Gregarina Locustae Carolinae*, (1); *Gregarina Locustae carolinae*, (2); *Gregarina fimbriata*, (3); *Gregarina Locustae*, (4), (5); *Gregarina locustaecarolinae*, (6); *Stephanophora locustae-carolinae*, (7), (8); *Gregarina locustae-carolinae*, (9), (10); *Gregarina locustae*, (11), (12).
Hosts: (a) *Dissosteira carolina* (Linnaeus), (1), (9), (12).
Habitat: Alimentary canal, (1a); mid-intestine, (12a).
Distribution: Gary, Indiana, (12a); Wyncote, Pennsylvania, (9a).

Gregarina paranensis (Künckel d'Herculais, 1899) Watson, 1916.
References: (1) Künckel d'Herculais, 1899, 622; (2) Watson, 1916, 104.
Synonymy: *Clepsidrina paranensis*, (1); *Gregarina paranensis*, (2).
Hosts: (a) *Schistocerca paranensis* (Burmeister), (1).
Habitat: Alimentary canal, (1a).
Distribution: Parana, Argentina, (1a).

Gregarina acridiorum Léger, 1893.
References: (1) Léger, 1893, 811; (2) Wasielewski, 1896, 138, 139; (3) Léger, 1897, 27; (4) Labbé, 1899, 10; (5) Léger and Duboscq, 1901, 440, 441; (6) Léger and Duboscq, 1902b, 381, 423, 424, 430, 462; (7) Lühe, 1904, 91, 96, 134; (8) Léger and Duboscq, 1909, 88; (9) Wellmer, 1910, 531; (10) Wellmer, 1911, 112; (11) Watson, 1916a, 104.
Synonymy: *Clepsidrina acridiorum*, (1), (2), (5), (6); *Clepsidrina Acridiorum*, (3); *Gregarina acridiorum*, (4), (5), (6), (7), (8), (9), (10), (11).
Hosts: (a) *Tryxalis* sp., (1), (3); (b) *Oedipoda coerulescens* Linnaeus, (9), (10); (c) *Sphingonotus* sp., (3); (d) *Pamphagus* sp., (1), (3); (e) *Calliptamus italicus* (Linnaeus), (5), (6).
Habitat: Alimentary canal, (1a), (1d) (3a), (3c), (3d), (6e); mid-intestine, (10b).
Distribution: Nemours, Algeria, (1a), (1d); France, (3a), (3c), (3d), (6e); Germany, (9b), (10b).

Subdivision 3. Host, one of the Copiphorinae, subfamily of the Tettigoniidae.

Gregarina chagasi Pinto, 1918. (It is singular that this is the only protozoan parasite of any kind described for Tettigoniidae.)
References: (1) Pinto, 1918a, 49; (2) Pinto, 1919, 8; (3) Kamm, 1922a, 132; (4) Kamm, 1922b, 84.
Synonymy: Name unchanged.
Hosts: (a) *Neoconocephalus fratellus* (Griffini), (1).
Habitat: Alimentary canal, (1a).
Distribution: Manguinhos, Brazil, (1a).

Subdivision 4. Hosts, Gryllidae.

Gregarina kingi Crawley, 1907.
References: (1) Crawley, 1907, 221; (2) Sokolow, 1911, 279; (3) Ellis, 1913c, 271; (4) Watson, 1916a, 106; (5) this paper, parts II and III.
Synonymy: *Gregarina kingi*, (1), (2), (4), (5); *Gigaductus kingi*, (3).
Hosts: (a) *Gryllus assimilis* Fabricius, (1), (5).
Habitat: Alimentary canal, (1a); gizzard, (5a); enteric ceca, (5a); mid-intestine, (5a).
Distribution: Beach Haven, New Jersey, (1a); Franklin and Washington Counties, Ohio, (5a); Wyncote, Pennsylvania, (1a).

Gregarina galliveri Watson, 1915.
References: (1) Watson, 1915, 33; (2) Watson, 1916a, 111; (3) Kamm, 1922a, 130; (4) Kamm, 1922b, 84; (5) this paper, parts II and III.
Synonymy: Name unchanged.
Hosts: (a) *Gryllus assimilis* Fabricius, (1), (2), (5); (b) *Hapithus agitator agitator* Uhler, (5).
Habitat: Alimentary canal, (1a), (2a); crop and gizzard, (5a), (5b); enteric ceca, (5a), (5b); mid-intestine, (5a), (5b).
Distribution: Oyster Bay, New York, (1a), (2a); Franklin County, Ohio, (5a); Washington County, Ohio, (5a), (5b).

Division 3. Complex of structural similarities. Hosts, Raphidophorinae, subfamily of the Gryllacrididae.

Gregarina hadenoeci Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Hadenoecus puteanus* Scudder, (1).
Habitat: Mid-intestine, (1a).
Distribution: Washington County, Ohio, (1a).

Gregarina longiducta Ellis, 1913.
References: (1) Ellis, 1913b, 78; (2) Ellis, 1913c, 266; (3) Watson, 1916a, 107; (4) Kamm, 1922a, 129; (5) Kamm, 1922b, 83; (6) this paper, part II.
Synonymy: Name unchanged.
Hosts: (a) *Ceuthophilus pallidipes* E. M. Walker, (erroneously, according to T. H. Hubbell, called *C. maculatus* (Harris)), (1); (b) *Ceuthophilus meridionalis* Scudder, (erroneously, according to Hubbell, called *C. latens* Scudder), (1)
Habitat: Alimentary canal, (1a), (1b).
Distribution: Douglas Lake, Michigan, (1a), (1b).

Gregarina proteocephala Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Ceuthophilus gracilipes* (Haldeman), (1).
Habitat: Mid-intestine, (1a).
Distribution: Washington County, Ohio, (1a).

Gregarina stygia Watson, 1915.
References: (1) Watson, 1915, 33, (2) Watson, 1916a, 114; (3) Kamm, 1922a, 131; (4) Kamm, 1922b, 83; (5) this paper, part II.
Synonymy: Name unchanged.
Hosts: (a) Probably *Ceuthophilus gracilipes* (Haldeman), erroneously called *C. stygia* (Scudder), according to T. H. Hubbell. (1), (4).
Habitat: Alimentary canal, (1a).
Distribution. Cold Spring Harbor, New York, (1a).

Gregarina consobrina Ellis, 1913.
References: (1) Ellis, 1913c, 267; (2) Watson, 1916a, 108; (3) Kamm, 1922a, 128, (4) Kamm, 1922b, 83; (5) this paper, part II.
Synonymy: Name unchanged.
Hosts: (a) *Ceuthophilus uniformis* Scudder, (1).
Habitat: ?
Distribution: Near Boulder, Colorado, (1a).

Gregarina sp.
References: (1) This paper, parts II and III.
Hosts: (a) *Ceuthophilus divergens* Scudder, (1).
Habitat: Mid-intestine, (1a).
Distribution: Franklin County, Ohio, (1a).

Gregarina neglecta Watson, 1916.
References: (1) Watson, 1916b, 69; (2) Kamm, 1922a, 131; (3) Kamm, 1922b, 83; (4) this paper, part II.
Synonymy: Name unchanged.
Hosts: (a) Uncertain. *Ceuthophilus nigricans* Scudder, or, possibly, *Ceuthophilus brevipes* Scudder, or? (According to T. H. Hubbell.), (1).
Habitat: ? (1a).
Distribution: Oyster Bay, New York, (1a).

Gregarina ceuthophili Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Ceuthophilus gracilipes* (Haldeman), (1); (b) *Ceuthophilus brevipes* Scudder, (1); (c) *Ceuthophilus divergens* Scudder, (1).
Habitat: Mid-intestine, (1a), (1b), (1c).
Distribution: Fairfield and Washington Counties, Ohio, (1a); Franklin County, Ohio, (1c); Licking County, Ohio, (1b).

Gregarina prima Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Ceuthophilus uhleri* Scudder, (1).
Habitat: Mid-intestine, (1a).
Distribution: Fairfield and Logan Counties, Ohio, (1a).

Gregarina udeopsyllae Watson, 1916.
References: (1) Watson, 1916a, 117; (2) Kamm, 1922a, 131; (3) Kamm, 1922b, 84; (4) this paper, part II.
Synonymy: Name unchanged.
Hosts: (a) *Udeopsylla robusta* (Haldeman), (1).
Habitat: Mid-intestine, (1a).
Distribution: Urbana, Illinois, (1a).

Division 4. *Leidyana*-like cephalont. Hosts, Gryllidae.

Gregarina macrocephala (Schneider, 1875) Labbé, 1899.
References: (1) Schneider, 1876, 18, 19, 32, 86; (2) Schneider, 1882, 442; (3) Schneider, 1885,

25; (4) Kunstler, 1887, 47; (5) Schneider, 1887, 73; (6) Léger, 1892, 67; (7) Léger, 1893, 811; (8) Wasielewski, 1896, 34, 137; (9) Cuénot, 1897, 54; (10) Léger, 1897, 10; (11) Labbé, 1899, 10; (12) Cuénot, 1901, 595; (13) Lühe, 1904, 139, 149; (14) Watson, 1916a, 102.

Synonymy: *Clepsidrina macrocephala*, (1), (2), (3), (4), (5), (6), (7), (8), (10); *Clepsidrina gryllorum*, (9); *Gregarina macrocephala*, (11), (12), (13), (14).

Hosts: (a) *Acheta campestris* (Linnaeus), (1); (b) *Gryllus domesticus* Linnaeus, (9), (11); (c) *Nemobius sylvestris* (Bosc d'Antic), (2), (11).

Habitat: Alimentary canal, (2c), (9b), (11b), (11c).

Distribution: France, (1a), (2c); Ardennes, France, (9b).

Division 5. Protomerite of satellite almost obliterated. Hosts, Acrydiinae, subfamily of Acrididae.

Gregarina acrydiinarum Semans, 1939.

References: (1) This paper, parts II and III.

Hosts: (a) *Acrydium arenosum angustum* Hancock, (1); (b) *Paratettix cucullatus cucullatus* (Burmeister), (1).

Habitat: Mid-intestine, (1a), (1b).

Distribution: Franklin County, Ohio, (1a); Delaware County, Ohio, (1b).

Division 6. Relationships not apparent.

Gregarina oviceps Diesing, 1859.

References: (1) Leidy, 1853a, 238; (2) Leidy, 1856, 47; (3) Diesing, 1859, 728; (4) Lankester, 1863, 94; (5) Labbé 1899, 35; (6) Crawley, 1903a, 45; (7) Crawley, 1903b, 639; (8) Crawley, 1907, 220; (9) Ellis, 1913c, 266; (10) Watson, 1915, 34; (11) Watson, 1916a, 101; (12) Bhatia and Setna, 1924, 287; (13) this paper, parts II and III.

Synonymy: *Gregarina Achetae abbreviatae*, (1), (2); *Gregarina oviceps*, (3), (11), (12), (13); *Gregarina Achetae*, (4); *Gregarina achetaeabbreviatae*, (5), (6), (7); *Gregarina achetae-abbreviatae*, (8), (9), (10).

Hosts: (a) *Gryllus assimilis* Fabricius, (1), (8), (9), (11), (13); (b) *Gryllus* spp., (12).

Habitat: Alimentary canal, (11a); gizzard, (1a), (12b), (13a); mid-intestine, (12b), (13a).

Distribution: Lahore, India, (12b); Urbana, Illinois, (11a); Douglas Lake, Michigan, (9a); Beach Haven, New Jersey, (8a); Oyster Bay, New York, (11a); Franklin and Washington Counties, Ohio, (13a); Haverford and Philadelphia, Pennsylvania, (11a); Wyncote, Pennsylvania, (8a).

Gregarina davini Léger and Duboscq, 1899.

References: (1) Léger and Duboscq, 1899, 38; (2) Léger and Duboscq, 1902b, 380, 461; (3) Mercier, 1908a, 377; (4) Sokolow, 1911, 278; (5) Watson, 1916a, 126.

Synonymy: *Gregarina Davini*, (1), (2), (5); *Clepsidrina davini*, (3); *Gregarina davini*, (4).

Hosts: (a) *Gryllomorpha dalmatina* (Ocskay de Ocskö), (1).

Habitat: Mid-intestine, (1a).

Distribution: France ?, (1a).

Gregarina ovata Dufour, 1828.

References: (1) Dufour, 1828, 367; (2) Dufour, 1837, 12; (3) Siebold, 1837, 408; (4) Hammerschmidt, 1838; (5) Desmarest, 1845, 317; (6) Frantzius, 1846; (7) Frantzius, 1848, 194, 195; (8) Diesing, 1851, 10; (9) Leidy, 1853a, 233; (10) Diesing, 1859, 731; (11) Lankester, 1863, 94; (12) Schneider, 1873, 515; (13) Schneider, 1876, 90; (14) Schneider, 1882, 442; (15) Balbiani, 1884, 13; (16) Schneider, 1885, 25; (17) Wasielewski, 1896, 22, 33, 137; (18) Labbé, 1899, 10; (19) Paehler, 1904, 64; (20) Schnitzler, 1905, 309; (21) Léger and Duboscq, 1909, 85; (22) Brindley and Potts, 1910, 836; (23) Wellmer, 1910, 531; (24) Wellmer, 1911, 106, 111; (25) Ellis, 1913c, 265; (26) Watson, 1916a, 97; (27) Brindley, 1918, 167; (28) Schiffman, 1919, 84; (29) this paper, part II.

Synonymy: *Gregarina ovata*, (1), (2), (3), (5), (6), (7), (8), (9), (10), (11), (12), (15), (18), (19), (21), (22), (23), (24), (25), (26), (28), (29); *Clepsidrina conoidea*, (4); *Clepsidrina ovata*, (13), (14), (16), (17), (20), (27).

Hosts: (a) *Acheta campestris* (Linnaeus), (2); (b) *Forficula auricularia* Linnaeus. (This insect belongs to the family Forficulidae of the Dermaptera, formerly, but no longer, included in the Orthoptera.) (1), (12), (13), (19), (20), (23), (24), (27); (c) *Forficula* sp., (22).

Habitat: Alimentary canal, (1b), (19b), (20b), (22c), (24b), (27b); mid-intestine, (12b).

Distribution: France, (1b), (13b); East Prussia, (23b); Marburg, Germany, (20b); St. Marys, Isles of Scilly, (27b); Farne Islands, (22c).

Gregarina legeri Pinto, 1918.

References: (1) Pinto, 1918a, 113; (2) Pinto, 1918b, 322; (3) Pinto, 1919, 86; (4) Kamm, 1922a, 140.

Synonymy: Name unchanged.

Hosts: (a) *Periplaneta americana* (Linnaeus), (1).

Habitat: Alimentary canal, (1a).

Distribution: Rio de Janeiro, Brazil, (1a).

Gregarina sphaerulosa Dufour, 1837. (Only cyst is known.)
References: (1) Dufour, 1837, 12; (2) Frantzius, 1846; (3) Diesing, 1851, 11; (4) Diesing, 1859, 732; (5) Lankester, 1863, 94; (6) Léger, 1892, 112; (7) Labbé, 1899, 13; (8) Watson, 1916a, 126.
Synonymy: *Gregarina sphaerulosa*, (1), (3), (4), (5), (8); *Eirmocystis gryllotalpae*, (6); *Hirmocystis gryllotalpae*, (7).
Hosts: (a) *Gryllotalpa* spp., (1); (b) *Oedipoda* spp., (1).
Habitat: Mid-intestine, (1a), (1b).
Distribution: France: (1a), (1b).

Genus 4. **Protomagalhaensia** Pinto, 1918. Spores barrel-shaped with spine at each corner. Sporonts attenuated, several individuals in association, often attached laterally.

Protomagalhaensia serpentula (Magalhães, 1900) Pinto, 1918.
References: (1) Magalhães, 1900, 43; (2) Sokolow, 1911, 278; (3) Ellis, 1913c, 266; (4) Watson, 1916a, 104; (5) Pinto, 1918b, 321; (6) Kamm, 1922a, 133.
Synonymy: *Gregarina serpentula*, (1), (2), (3), (4); *Protomagalhaensia serpentula*, (5), (6).
Hosts: (a) *Periplaneta americana* (Linnaeus), (1).
Habitat: Coelom and alimentary canal, (1a).
Distribution: Rio de Janeiro, Brazil, (1a).

Genus 5. **Gamocystis** Schneider, 1875. Associative. Protomerite only in young stages. Sporulation partial, with spore ducts. Spores cylindric.

Gamocystis tenax Schneider, 1875.
References: (1) Schneider, 1876, 99, etc.; (2) Schneider, 1882, 444, 445; (3) Balbiani, 1884, 13, 50; (4) Wasielewski, 1896, 36, 136; (5) Labbé, 1899, 12; (6) Luhe, 1904, 155; (7) Wellmer, 1910, 532; (8) Wellmer, 1911, 108, 122; (9) Ellis, 1913c, 271; (10) Watson, 1916a, 122.
Synonymy: Name unchanged.
Hosts: (a) *Ectobia lapponica* (Linnaeus), (1), (7), (8).
Habitat: Alimentary canal, (1a), (8a).
Distribution: France, (1a); East Prussia, (7a); Germany, (8a).

Genus 6. **Tettigonospora** Smith, 1930. Associative. Dehiscence by spore ducts. Spores spherical.

Tettigonospora stenopelmati (Smith, 1929) Smith, 1930.
References: (1) Smith, 1929, 57; (2) Smith, 1930, 445.
Synonymy: *Coccospora stenopelmati*, (1); *Tettigonospora stenopelmati*, (2).
Hosts: (a) *Stenopelmatus pictus* Scudder, (1); (b) *Stenopelmatus fuscus* Haldeman, (1); (c) *Stenopelmatus intermedius* Davis and Smith, (2).
Habitat: Ceca and mid-intestine, (1a), (1b); excrement, (2c).
Distribution: Central California, (1a), (1b); Oakland, California, (2c).

Genus 7. **Hirmocystis** Labbé, 1899. Associations of from 2 to 12 or more. Epimerite a small, cylindric papilla. Cysts dehisce by simple rupture. Spores ovoid.

Hirmocystis gryllotalpae (Léger, 1892) Labbé, 1899.
References: (1) Léger, 1892, 112; (2) Wasielewski, 1896, 35; (3) Léger, 1897, 11; (4) Labbé, 1899, 13; (5) Watson, 1916a, 123.
Synonymy: *Gregarina sphaerulosa*, (1), (4); *Eirmocystis gryllotalpae*, (1), (2); *Eirmocystis Gryllotalpae*, (3); *Hirmocystis gryllotalpae*, (4), (5).
Hosts: (a) "Courtilieres" (a gryllid), (1).
Habitat: Alimentary canal, (1a).
Distribution: Vallee du Clain, Poitou, France, (1a).

Family 2. *Actinocephalidae* Léger, 1892.

Sporonts solitary. Epimerite varied. Cysts dehisce by simple rupture. Spores irregular, biconic, or cylindro-biconic.

Genus 1. **Pileocephalus** Schneider, 1875. Epimerite a lance-shaped or simple cone. Spores ovoid, pointed.

Pileocephalus tachycines Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Tachycines asinamorus* (Adelung), (1).
Habitat: Mid-intestine, (1a).
Distribution: Franklin County, Ohio, (1a).

Pileocephalus blaberae (Frenzel, 1892) Labbé, 1899.
References: (1) Frenzel, 1892, 300; (2) Wasielewski, 1896, 136; (3) Labbé, 1899, 20; (4) Ellis, 1913c, 266; (5) Watson, 1916a, 123; (6) This paper, part II.

Synonymy: *Gregarina blaberae*, (1), (2), (4); *Pileocephalus blaberae*, (3), (5), (6).
Hosts: (a) *Blaptica dubia* (Serville), and related species, (1).
Habitat: Mid-intestine, (1a).
Distribution: Cordoba, Argentina, (1a).

Genus 2. **Actinocephalus** Stein, 1848. Epimerite small, sessile or on a short neck, with 8 or 10 short, sharp spines or simple, bifurcate digitiform processes. Spores biconic.

Division 1. South African species.

Actinocephalus giganteus Bush, 1928.
References: (1) Bush, 1928, 149, et. al.
Synonymy: Name unchanged.
Hosts: (a) "Majority of the grasshopper species." (This refers to 35 ? species of "Acridiidae" examined by Bush.) " . . . did not occur in *Locustana pardalina*," (1).
Habitat: Alimentary canal, (1a).
Distribution: Pietermaritzburg, Natal, (1a).

Actinocephalus sp. Bush, 1928.
References: (1) Bush, 1928, 152, et. al.
Hosts: (a) *Parga xanthoptera* (Stal), (1); (b) *Catantops humeralis* (Thunberg), (1).
Habitat: Alimentary canal, (1a), (1b).
Distribution: Pietermaritzburg, Natal, (1a), (1b).

Actinocephalus amphoriformis Bush, 1928.
References: (1) Bush, 1928, 149, et. al.
Synonymy: Name unchanged.
Hosts: (a) "Practically all the species of grasshoppers." (This refers to 35 ? species of "Acridiidae" examined by Bush.) . . . "did not occur in *Locustana pardalina*." (1).
Habitat: Alimentary canal, (1a).
Distribution: Pietermaritzburg, Natal, (1a).

Division 2. North American species.

Actinocephalus sp.
References: (1) This paper, parts II and III.
Hosts: (a) *Pardalophora apiculata* (Harris), (1).
Habitat: Mid-intestine, (1a).
Distribution: Washington County, Ohio, (1a).

Actinocephalus fimbriatus (Diesing, 1859) Watson, 1916.
References: (1) Leidy, 1853a, 239; (2) Leidy, 1856, 47; (3) Diesing, 1859, 730; (4) Crawley, 1903a, 54; (5) Crawley, 1903b, 640; (6) Crawley, 1907, 226; (7) Ellis, 1913c, 278; (8) Watson, 1916a, 124; (9) this paper, part II.
Synonymy: *Gregarina Locustae Carolinae*, (1); *Gregarina Locustae carolinae*, (2); *Gregarina fimbriata*, (3); *Stephanophora locustaecarolinae*, (4), (5); *Stephanophora pachyderma*, (6); *Actinocephalus pachydermus*, (7); *Actinocephalus fimbriatus*, (8), (9).
Hosts: (a) *Dissosteira carolina* (Linnaeus), (1), (6).
Habitat: Alimentary canal, (1a).
Distribution: Wyncote, Pennsylvania, (6a).

Actinocephalus elongatus Semans, 1939.
References: (1) This paper, parts II and III.
Hosts: (a) *Dichromorpha viridis* (Scudder), (1); (b) *Arphia sulphurea* (Fabricius), (1); (c) *Chortophaga viridifasciata* (DeGeer), (1); (d) *Schistocerca americana americana* (Drury), (1, *A. elongatus* ?); (e) *Melanoplus mexicanus mexicanus* (Saussure), (1, *A. elongatus* ?).
Habitat: Coelom, (1c); enteric ceca, (1c), (1b); mid-intestine, (1a), (1c), (1d).
Distribution: Fairfield County, Ohio, (1c); Franklin County, Ohio, (1d); Washington County, Ohio, (1a), (1b), (1c).

Genus 3. **Legeria** Labbé, 1899. Epimerite not known. Protomerite dilated and massive. Septum convex upward. Spores cylindro-conic.

Legeria sp. Bush, 1928. (Possibly the immature of the South African *Gregarina nigra* Watson. See this paper, part II, under *Gregarina indianensis* n. sp.)
References: (1) Bush, 1928, 153, et. al.
Hosts: (a) *Phloeonotus jugatus* (F. Walker), (1).
Habitat: Alimentary canal, (1a).
Distribution: Pietermaritzburg, Natal, (1a).

Subclass 2. NEOSPORIDIA Schaudinn, 1900.

Spores formed more or less continuously throughout the trophic stages, the sporoblasts being carried about with the organism, which may ultimately become a huge mass of spores.

Order 1. MICROSPORIDIA Balbiani, 1884.

Small spores, frequently less than 5 microns in length. Possess one, or exceptionally, two polar capsules, which under pressure extrude exceedingly long filaments.

Family 1. *Nosematidae* Labbé, 1899.

Ovoid or pyriform spores developed from uninucleate rounded bodies which are the products of multiple or binary fission of the vegetative forms.

Genus 1. **Plistophora** Gurley, 1893. Each sporont gives rise to many spores, more than 16.

Plistophora periplanetae (Lutz and Splendore, 1903) Perrin, 1905.
References: (1) Schaudinn, 1902, 309; (2) Lutz and Splendore, 1903, 154; (3) Perrin, 1905, 204; (4) Mercier, 1906a, 1083; (5) Perrin, 1906, 615; (6) Mercier, 1908a, 373; (7) Mercier, 1908c, 41; (8) Shiwago, 1909, 647; (9) Wellmer, 1910, 532; (10) Epstein, 1911, 677; (11) Shiwago, 1911, 49; (12) Wellmer, 1911, 145; (13) Swarczewsky, 1914, 50, 74, 91; (14) Georgévitch, 1925a, 1191; (15) Georgévitch, 1925b, 102, 104; (16) Georgévitch, 1927, 9.
Synonymy: Not named, (1); *Nosema periplanetae*, (2); *Pleistophora periplanetae*, (3), (5), (8), (9), (10), (11), (12), (13), (14), (15); *Plistophora periplanetae*, (4), (7,) (16), (17).
Hosts: (a) *Blattella germanica* (Linnaeus), (12); (b) *Blatta orientalis* Linnaeus, (3), (4), (8), (9), (10), (12), (14); (c) *Periplaneta americana* (Linnaeus), (2); (d) "Blattes," (15).
Habitat: Alimentary canal, (2c); Malpighian tubules, (3b), (4b), (8b), (10b), (12a), (12b), (15d).
Distribution: Brazil, (2c); England, (3b); France, (4b); Konigsberg, Germany, (12b); Munich, Germany, (10b); East Prussia, (9b); Moscow, Russia, (8a), (8b), (10b); Belgrade, Yugoslavia, (14b).

Species related to *Plistophora periplanetae* (Lutz and Splendore, 1903) mentioned by Lutz and Splendore, 1903.
References: (1) Lutz and Splendore, 1903, 154.
Hosts: (a) *Gryllotalpa* sp., (1).
Habitat: Mid-intestine, wall, (1a).
Distribution: Brazil, (1a).

Species related to *Plistophora periplanetae* (Lutz and Splendore, 1903) mentioned by Perrin, 1905.
References: (1) Perrin, 1905, 208.
Hosts: (a) *Blatta orientalis* Linnaeus, (1).
Habitat: Malpighian tubules, (1a).
Distribution: England, (1a).

Plistophora sp. Mercier.
References: (1) Mercier, 1908, 373; (2) Kudo, 1924, 178.
Hosts: (a) *Blatta orientalis* Linnaeus, (1).
Habitat: Fat bodies, (1a).
Distribution: ?

Order 2. HAPLOSPORIDIA Lühe, 1900.

Spores spherical or ovoid, the surface variously marked with ridges, but without polar capsules. Possess a tail-like process in some cases.

Genus 1. **Coelosporidium** Mesnil and Marchoux, 1897. Body small, forming cysts. Spore without a filament.

Coelosporidium periplanetae (Lutz and Splendore, 1903) Swarczewsky, 1914.
References: (1) Lutz and Splendore, 1903, 154; (2) Crawley, 1905, 158; (3) Caullery and Mesnil, 1905, 108, 160; (4) Doflein, 1909, 816; (5) Wellmer, 1911, 146; (6) Swarczewsky, 1914, 91, 101, 104; (7) Kudo, 1922, 113; (8) Kudo, 1924, 188; (9) Georgévitch, 1927, 9; (10) Kudo, 1931, 332.
Synonymy: *Nosema periplanetae*, (1); *Coelosporidium blattellae*, (2), (3); *Bertramia blatellae*, (4), (5); *Coelosporidium periplanetae*, (6), (7), (8), (9), (10).
Hosts: (a) *Blattella germanica* (Linnaeus), (2), (5); (b) *Blatta orientalis* Linnaeus, (7).
Habitat: Malpighian tubules, (2a), (5a).
Distribution: Königsberg, Germany, (5a); United States, (2a); Urbana, Illinois, (7b).

THE OHIO JOURNAL OF SCIENCE

VOL. XLIII NOVEMBER, 1943 No. 6

CONTRIBUTIONS TO THE STRATIGRAPHY OF THE ALLEGHENY SERIES IN COLUMBIANA AND MAHONING COUNTIES, OHIO

PART I. STRATIGRAPHY AND CORRELATION OF THE COALS AND LIMESTONE BELOW THE LOWER KITTANNING COAL

MYRON T. STURGEON,
Michigan State Normal College,
Ypsilanti, Michigan

The general stratigraphic section and many of the details of the geology of Columbiana and Mahoning Counties are known from the published reports of Newberry, Orton, Stout and Lamborn, and others. As time goes on, however, new data that add to the already existing store of geologic knowledge or that necessitate some minor revision of the present correlation of the various strata are discovered. Some years ago I began the study of the invertebrate fossils of the Allegheny Series in that portion of these two counties within the Lisbon Quadrangle, and as the study has progressed some new facts concerning the stratigraphy have been found. It is proposed to present this new information in three separate parts under the general title given above (see Fig. 1):

Part I. Stratigraphy and Correlation of the Coals and Limestone below the Lower Kittanning Coal.
Part II. Stratigraphy of the Middle Kittanning Coal between Greenford and Washingtonville, Ohio.
Part III. Stratigraphy, Petrology, and Paleontology of the Salem Limestone.

LOCATION

There are two coals and one shaly marine limestone below the Lower Kittanning coal and above drainage in the northeastern quarter of the Lisbon Quadrangle. The limestone is closely associated with the lowermost coal, and these two members occur in Sections 4, 7, and 18, Green Township, Mahoning County. Other exposures of the same members are known further north in the adjacent Warren Quadrangle, and this same coal without the overlying shaly limestone may be present along Little Beaver Creek south of New Albany.

The Lower Kittanning coal is 25 to 35 feet higher than the above members, and a few inches to several feet below the base of the Lower Kittanning coal is the second coal which is normally thin and irregular in distribution. This second coal is present in localities under consideration at present from the northern edge of the Lisbon Quadrangle at least as far south as Section 15, Salem Township, and also at Coleman in Section 9, Center Township, Columbiana County. It is reasonably certain that the lowermost coal and the limestone are the Clarion and Vanport members, respectively, and the coal occurring just below the Lower Kittanning coal is without doubt the Lawrence coal.

The various known localities of these three members in this vicinity are shown in Figure 2, and the stratigraphic sections are plotted in Figure 4.

STRATIGRAPHY

Clarion Coal and Vanport Limestone.—Lamb, who was apparently the first to observe and mention the Vanport limestone in this area, described it in 1910 under the name of Howenstein limestone on the Ira Unger farm along a tributary to Meander Creek in the northwest quarter, Section 4, Green Township, Mahoning County.[1] The strata along this small stream are of special interest; for there are two closely associated coal beds further upstream on the John Ewing (now

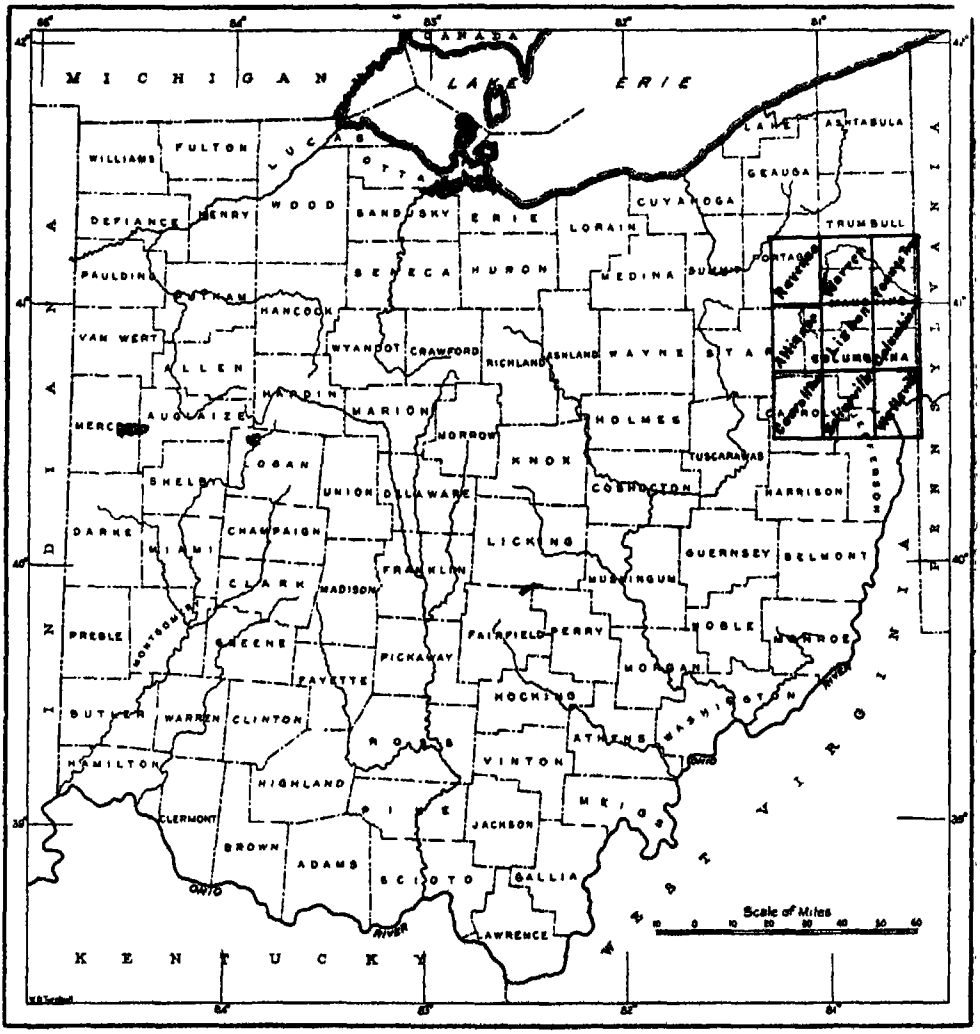


Fig. 1. Map of Ohio showing location of Columbiana and Mahoning counties and the Lisbon and surrounding quadrangles.

---

[1] Lamb, G. F.: *Pennsylvanian Limestones of Northeastern Ohio below the Lower Kittanning Coal*, Ohio Naturalist, vol. 10, pp. 115–117. (1910.)

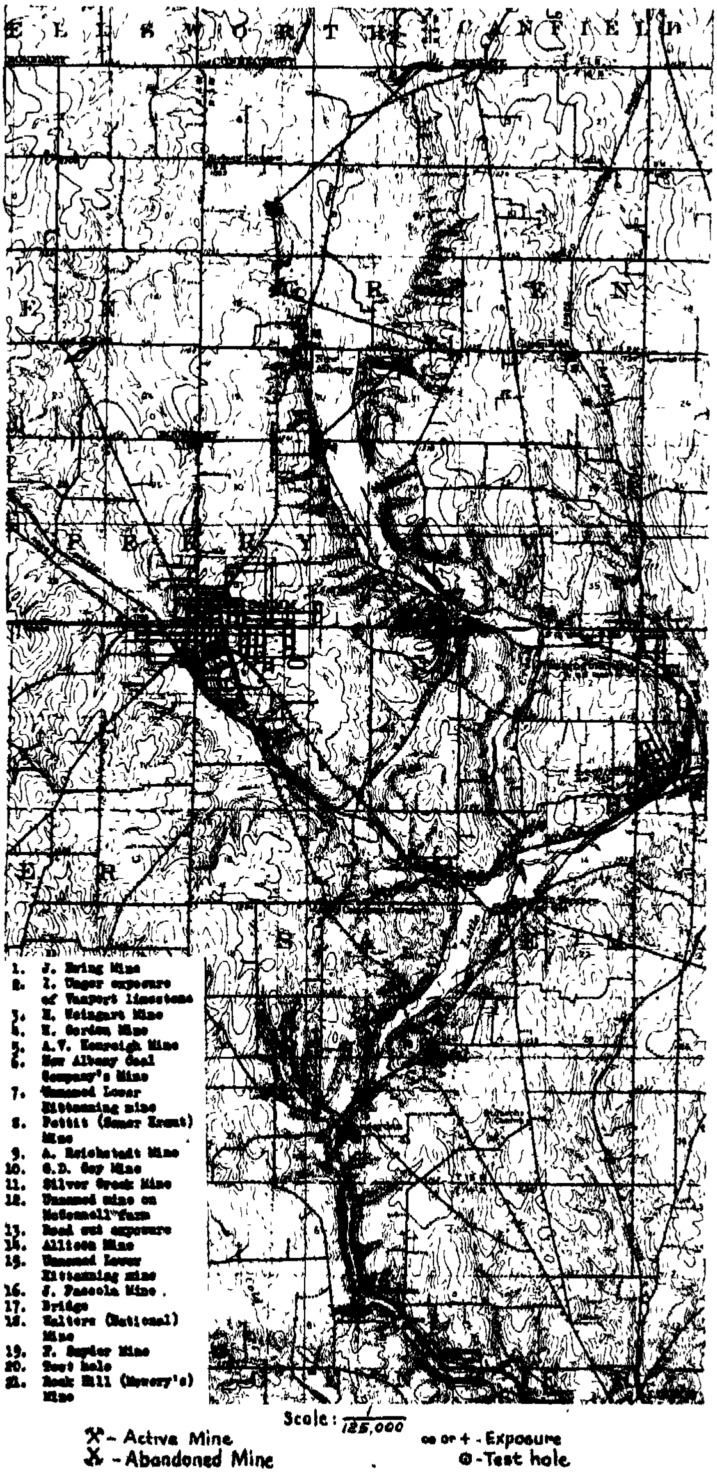


Fig. 2. Northeastern portion of the Libson Quadrangle showing locations of stratigraphic sections described in the text and shown in the correlation diagram (Fig. 4).

Ray Hagstrom) farm in the southwest corner of Canfield Township, Mahoning County. These two coals were formerly mined, although the lower coal was of very poor quality (See Figure 3A). Mining probably began before 1878, for in that year Newberry wrote as follows:[2]

> "On the Erving farm, in the southwest corner of Canfield (township) it is two and a half feet thick, two feet bituminous, and six inches of the upper part cannel. Here another coal seam two feet thick, probably Coal No. 3a, lies about eight feet under it, but the interval is usually much greater."

Although Newberry wrote "Erving" instead of "Ewing," the location and description given are those of the locality under discussion.

Orton visited the locality when the mining of the upper coal was still in progress, and identified it as the Canfield Cannel or Scrub Grass or Upper Clarion coal in 1884.[3] Orton's interpretation would identify the lower coal as the Clarion as recognized in the standard section for the Pennsylvanian System by the present Geological Survey of Ohio.[4] The mines are long since abandoned (See Fig. 3B) and only the upper coal can be seen in very limited exposures near the old mine entrance and along the adjacent road. In August, 1938, I visited this valley and with the help of information from Mr. Elmer Ewing and Mr. Ira Unger determined the following section and interpretation of it:

15.	Glacial till		19′ 6″
14.	"Draw slate"		1′ 6″
13.	Coal: cannel	*Lower Kittanning*	0′ 5″
12.	Coal: bituminous		1′ 10″
11.	Clay: plastic		7′ 0″
10.	Shale		1′ 0″
9.	Coal: bituminous, poor quality, *Lawrence*		1′ 10″ to 3′ 2″
8.	Clay: plastic (?)		
7.	Shale: gray, arenaceous, with few plant fossils		9′ 0″
6.	Shale and sandstone: upper 15–18 feet consists largely of gray, fine grained, thin bedded, and micaceous sandstone with some interbedded shale layers, lower part is gray, arenaceous, and micaceous shale with layers or lenses of fine grained sandstone up to several feet in thickness		30′ 0″
5.	Shale: gray, fossiliferous, with clay ironstone concretions	*Vanport*	3′ 9″
4.	Limestone: dark gray to black, somewhat flinty in appearance, but actually not siliceous, shaly appearance on weathering, fossiliferous		1′ 6″
3.	Shale: dark gray, fossiliferous, with 1-inch ferruginous layer at top, exposed		1′ 6″
2.	Covered interval		17′ 6″
1.	Coal: reported to be thin, *Clarion*.		

---

[2] Newberry, J. S.: *Report on the Geology of Mahoning County,* Geol. Surv. Ohio, vol. III, pp. 795–796. (1878.)

[3] Orton, Ed.: *The Stratigraphical Order of the Lower Coal Measures of Ohio,* Geol. Surv. Ohio, vol. V, pp. 31 and 34. (1884.)

[4] Bownocker, J. A., and Dean, E. S.: *Analyses of the Coals of Ohio,* Geol. Surv. Ohio, 4th series, Bull. 34, chart opposite p. 6. (1929.)

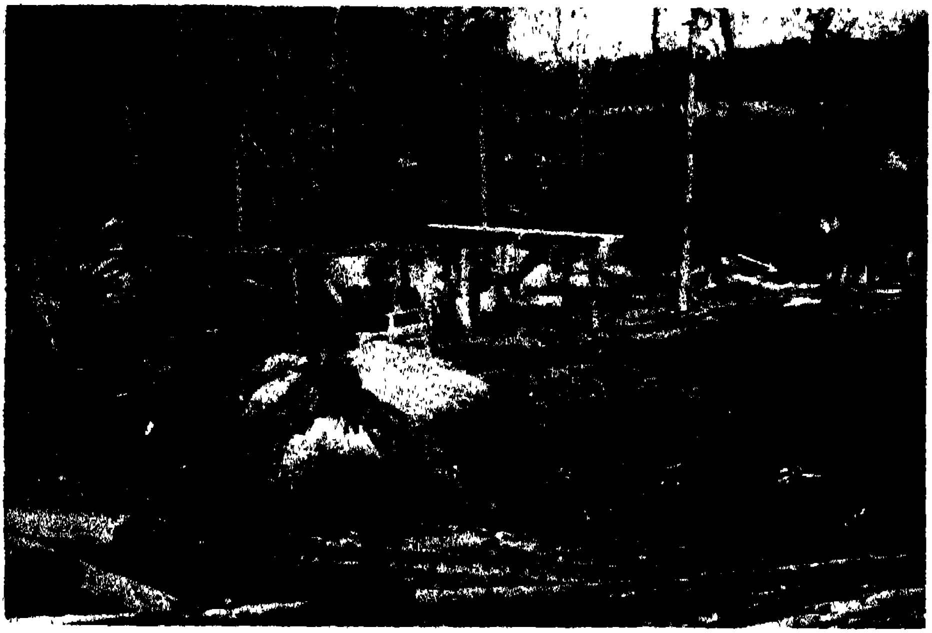


Fig. 3. A. The Ewing Mine from the south side at about the time of its abandonment in 1908 or 1909. The white line marks the approximate dip of the Lower Kittanning coal toward the east, and the arrow points to the entrance of the slope to the Lawrence coal. The two men are John (left) and Elmer Ewing. Original photo by Herbert Knauf; reproduced here through the courtesy of Elmer Ewing.

Fig. 3. B. The above location today (May, 1943) from the southeast. The young man is standing on the same mound that the Ewings are in the above picture.

The Clarion coal is not exposed and is reported by Mr. Unger from a test drill hole. Orton reported fragments of a blue fossiliferous limestone above the cannel coal, and if these fragments were in place, they undoubtedly represent the Hamden limestone.

Mr. Nick Weingart formerly operated a small mine on the Clarion coal on the north side of the Little Beaver Creek in the east-central part of Section 7, Green Township, Mahoning County. I measured the following section in December, 1932:

7.	Shale: dark gray, argillaceous, sparingly fossiliferous, exposed	*Vanport*	1′ 8″
6.	Shale: similar to zone 5 but thinner bedded, very fossiliferous		0′ 10″
5.	Shale: dark gray to black, very fossiliferous; with an almost continuous layer of pyritiferous and fossiliferous limestone nodules		0′ 4″
4.	Coal: with numerous thin discontinuous marcasite partings and with calcite in joints near the top, *Clarion*		1′ 6″
3.	Clay: light gray with buff stain, plastic, arenaceous toward base		5′ 10″
2.	Shale: light gray with buff stain, arenaceous, grades into plastic clay above, exposed		2′ 0″
1.	Level of Little Beaver Creek.		

This locality was excellent for collecting invertebrate fossils, especially gastropods, cephalopods, and brachiopods.

On the farm of Harry Gordon across Little Beaver Creek from the abandoned Weingart mine I measured the following section in an abandoned mine entrance and a nearby wash in September, 1938:

10.	Shale: gray to buff, arenaceous; with numerous clay ironstone concretions, exposed		16′ 0″
9.	Shale: gray, fossiliferous	*Vanport*	2′ 6″
8.	Shale: dark gray to black, flinty in appearance, sparingly fossiliferous		1′ 0″
7.	Shale: dark gray, sparingly fossiliferous		5′ 0″
6.	Shale: gray, similar to but lighter gray than shale of zone 5, fossiliferous at least in basal part		7′ 6″
5.	Shale: dark gray, argillaceous, fossiliferous		8′ 0″
4.	Limestone: dark gray, shaly, fossiliferous		0′ 6″
3.	Shale: dark gray, fossiliferous		1′ 9″
2.	Coal: *Clarion*		1′ 6″
1.	Clay: plastic, unmeasured.		

A similar section but one that is less well known in detail occurs on the A. V. Kenreigh farm almost on the boundary between the northwest quarter and northeast quarter of Sections 17 and 18, respectively, Green Township, Mahoning County. There the exposure is along the channel of a small intermittent stream and in two shallow shafts that were dug several years ago to prospect the Clarion coal. The shafts were partly filled by water when visited in 1939, and the following section was determined partly by studying the refuse piles and the exposures along the stream and partly by information given by Mr. Kenreigh:

5.	Shale: weathered, unmeasured.		
4.	Limestone: dark gray to black, fossiliferous, similar in lithology to limestone on the Unger farm...........	*Vanport*.......	1′ 4″
3.	Shale: blue gray, fossiliferous; with small scattered clay ironstone concretions; thickness approximate...		8′ 0″
2.	Limestone: dark gray, nodular, fossiliferous...........		0′ 4″
1.	Coal, *Clarion*........		1′ 0″

It is assumed that the nodular limestone lies directly on the coal, as some of the nodules which are in the refuse piles have bits of coal adhering to them in the

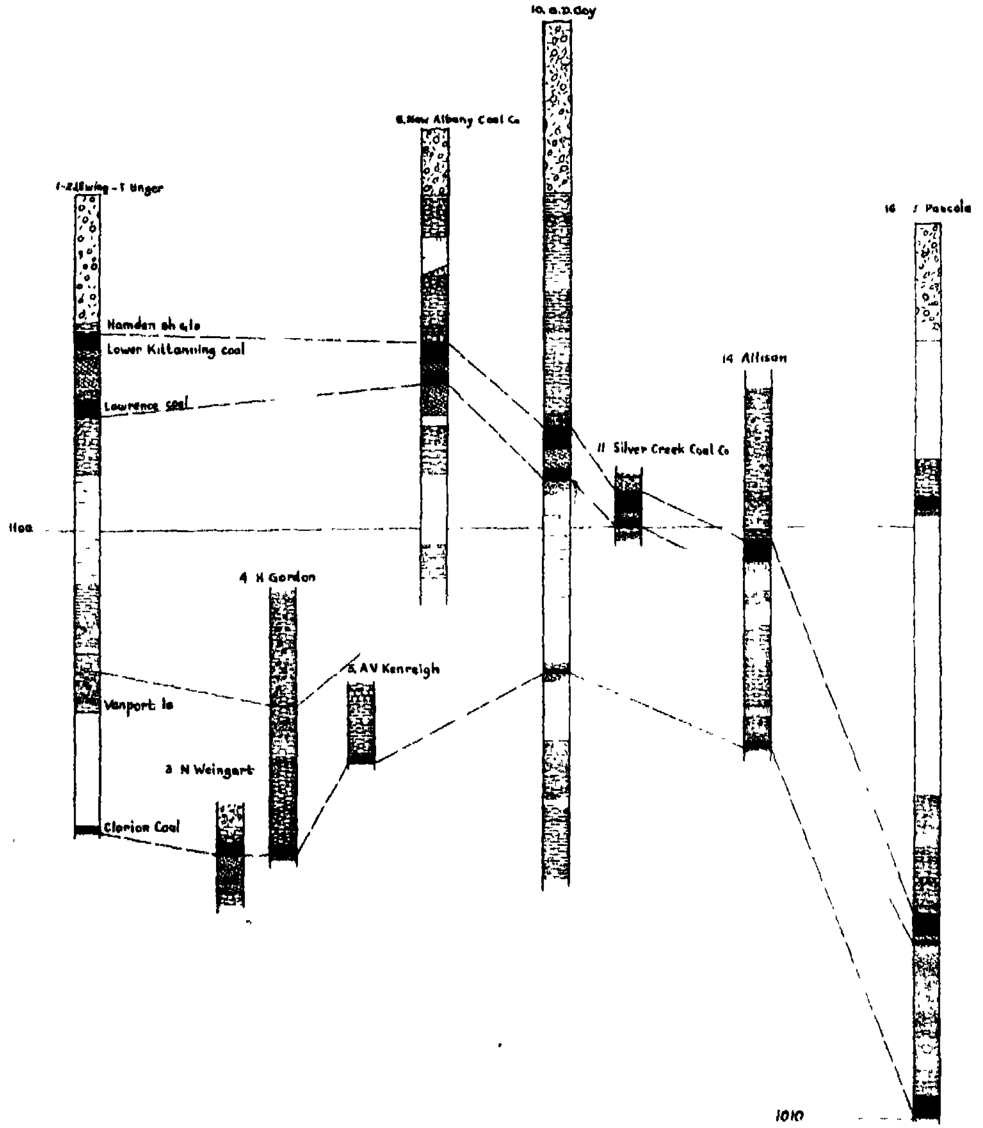


Fig. 4. Correlation diagram of the strata below the Lower Kittanning coal in the northeastern part of the Lisbon Quadrangle.

same manner as those at abandoned Weingart mine. It is reported by Mr. Kenreigh that the limestone, No. 4, in the above section was burned by his grandfather for lime almost a century ago and that mounds still mark the sites of those burnings.

It is evident from these four sections that the Vanport member is represented by a considerable thickness of fossiliferous shale with variable interbedded nodular or shaly limestone overlying the Clarion coal. This thickness reaches a known maximum at the abandoned mine on the Harry Gordon farm with a total of 21 feet. On the Kenreigh farm the known thickness is about 10 feet, and it is probable that the weathered shale on top of the limestone is also fossiliferous. The entire thickness of shale and limestone at the abandoned Weingart mine contains fossils but only 2 feet and 10 inches are exposed. There are 6 feet and 9 inches of fossiliferous strata exposed on the Unger farm, but if the 17 feet and 6 inches of strata overlying the coal below drainage are fossiliferous, the thickness of fossiliferous strata would be in excess of 24 feet. These sections are similar in lithology and of even greater thickness than those of the Vanport member described by Stout and Lamborn in Elk Run and St. Clair Townships, Columbiana County.[5]

As far as known there are no exposures of the Vanport member along Little Beaver Creek south of the exposure on the Kenreigh farm, but it may be covered by mantle rock along the lower slopes of the valley sides. In addition to the sections with the Vanport member there are four locations of coal, probably Clarion, known in this vicinity.

A short distance north of New Albany between the old and new locations of Route 62 at the buildings of the D. McConnell farm a shallow shaft to a coal below the Lower Kittanning coal was in operation during the First World War. This shaft has been abandoned and filled, and to date I have been unable to get any detailed information concerning it. It is reasonably certain that the Clarion coal was the coal mined in this shaft. Evidence concerning the presence of the Vanport member is wanting.

The other three are exposures, the first of which is located in a ravine near the New Albany-Greenford road in the southeast quarter of Section 16, Green Township, Mahoning County. The section here and in the nearby abandoned G. D. Coy shaft mine is as follows:

18.	Glacial till: cribbed		25'	0"
17.	Shale: gray, weathered		4'	0"
16.	Shale: gray		30'	0"
15.	Shale: gray, fossiliferous; with nodules of fossiliferous limestone, thickness variable	*Hamden*	1'	0"
14.	Shale: black, bony, fossiliferous		1'	3"
13.	Coal, *Lower Kittanning*		3'	0"
12.	Clay: gray, plastic		3'	4"
11.	Coal, *Lawrence*		1'	6"
10.	Clay: plastic, unmeasured.			
9.	Sandstone: gray or stained buff, fine, friable, micaceous, bedded; with shaly layers and lenses		20±'	
8.	Covered interval		6'	0"
7.	Shale: gray, weathered, exposed		1'	0"
6.	Coal, *Clarion*		0'	4"
5.	Clay: gray, arenaceous, plastic, exposed		1'	0"

---

[5] Stout, W., and Lamborn, R. E.: *Geology of Columbiana County*, Geol. Surv. Ohio, 4th series, Bull. 28, pp. 68–70. (1924.)

4.	**Covered interval**	9' 3"
3.	**Shale: gray; with clay ironstone concretions, exposed**	9' 1"
2.	**Covered interval**	1' 2"
1.	**Shale: gray, arenaceous, exposed**	11' 0"

The interval between the base of the Lower Kittanning coal and the top of the Clarion coal is a little more than 30 feet. No evidence of the Vanport member can be seen, but the exposure is poor. At places in the Coy mine there is a thin layer of cannel coal at the top of the Lower Kittanning coal. This is most common toward the eastern edge of the lease and in the swamps where the coal is thickest. The Hamden member is everywhere marine.

The Clarion coal is exposed at a little abandoned mine on the Allison farm in the northwest quarter, Section 29, Perry Township, Columbiana County. The section exposed here in September, 1938, is as follows:

14.	Sandstone: gray, thin bedded, micaceous, exposed		2' 0"
13.	Shale: gray, arenaceous and ferruginous; with numerous clay ironstone concretions		17' 0"
12.	Shale: light gray, argillaceous, soft		0' 9"
11.	Shale: dark gray, fossiliferous	*Hamden*	3' 6"
10.	Shale: dark gray, very fossiliferous; with fossiliferous limestone nodules		1' 0"
9.	Shale: black, bony, fossiliferous		0' 9"
8.	Coal, *Lower Kittanning*		3' 0"
7.	Clay: plastic	partly covered	22' 4"
6.	Shale: ?		
5.	Sandstone: gray weathering buff, a single ledge showing bedding on weathering		1' 5"
4.	Shale: gray and buff, arenaceous, thickness variable		3' 0"
3.	Clay-shale: light and dark, soft		0' 8"
2.	Coal, *Clarion*		0' 10"
1.	Clay: plastic; unmeasured.		

There are 27 feet and 5 inches between the base of the Lower Kittanning coal and the top of the Clarion coal in this section. It is possible that there may be fossils in the partly covered shale, zone 6 of the section, but none were seen.

John Pascola formerly operated a shaft mine under the name of the New Salem Coal Company on the south side of the Salem-Washingtonville road (Route 14) in the southern part of Section 33, Green Township, Mahoning County. Four coals are shown in this shaft and a slope which extends 24 feet deeper than the base of the shaft. The entire section measured in March, 1933, in this mine is given below:

18.	**Cribbing**	17' 6"
17.	**Sandstone: massive, *Lower Freeport***	18' 0"
16.	**Shale: dark gray**	6' 0"
15.	**Coal, *Middle Kittanning***	1' 6"
14.	**Clay: plastic**	1' 0"
13.	**Sandstone**	43' 0"
12.	**Shale: gray, argillaceous**	12' 6"

11.	Shale: gray, argillaceous, fossiliferous; with many clay ironstone concretions	*Hamden*	0′ 6″
10.	Shale: gray, argillaceous, fossiliferous; with few clay ironstone concretions		3′ 6″
9.	Shale: dark gray, calcareous, very fossiliferous; with fossiliferous limestone nodules		1′ 0″
8.	Shale: black, bony, fossiliferous		0′ 6″
7.	Coal: contains thin partings of marcasite, one of which near the top is about 1 inch thick and fairly persistent, *Lower Kittanning*		3′ 2″
6.	Clay: gray or gray-drab, plastic		1′ 0″
5.	Coal: locally present, *Lawrence*		0′ 5″
4.	Clay: gray, plastic		11′ 0″
3.	Shale: gray, arenaceous; with some clusters of clay ironstone concretions		12′ 0″
2.	Coal: interbedded with thin lensing layers of shale containing plant fossils	*Clarion*	0′ 3″
1.	Coal: contains numerous thin shaly partings. One of these partings is an inch or so in thickness near the base of the thicker portions of the coal		2′ 8″

It is certain that there are no marine fossils in the shale overlying the Clarion coal in this section. An attempt was made to mine the Clarion coal here, but while it was of sufficient thickness, the quality was such that the attempt was soon abandoned. It is reported that a bed of coal was exposed in the channel of Little Beaver Creek about one-half mile northeast of the Pascola shaft when the highway bridge was built at that point a few years ago. If this is true, the coal is also the Clarion member.

At Long's Crossing located five miles south of the Pascola shaft in the southeast quarter, Section 28, Salem Township, Columbiana County, the Clarion member is absent but the underclay is apparently present as shown in a test hole drilled from near the base of the Upper Freeport coal to a depth of 253 feet. A record of this test hole is available through the courtesy of Mr. Homer Callahan, and the portion of the record from the Lower Kittanning coal to the Clarion clay is given:

10.	Coal, *Lower Kittanning*	2′ 8″
9.	Clay	4′ 4″
8.	Shale: gray	3′ 6″
7.	Clay	2′ 6″
6.	Shale: gray	7′ 0″
5.	Shale: brown	3′ 0″
4.	Shale: gray	4′ 0″
3.	Sandstone: gray; with streaks of shale	12′ 0″
2.	Clay, *Clarion* (?)	2′ 0″
1.	Sandstone and shale: gray	30′ 0″

The interval between the Lower Kittanning coal and the Clarion clay is about 36 feet.

The Allison and Pascola sections show that the Clarion coal is present along Little Beaver Creek as far south as the Columbiana-Mahoning county line east of the City of Salem. Thus the Clarion coal is present for a distance of six miles from the northern to southern boundaries of Green Township, Mahoning County, along the headwaters of Meander Creek and Little Beaver Creek, and in the northern two miles of this extent the associated Vanport member is also present. In this area the Clarion coal has been prospected and mined to a very limited extent, but it had practically no economic value in the past and promises to have little in the future because of its irregular and thin development and because of its poor quality. The Vanport member has been used to a very limited extent for agricultural lime in times past, but its shaly and impure character give little or no promise for future uses. Both the Clarion and Vanport members are useful to the stratigrapher in determining the complete stratigraphic section of this area.

The Lawrence Coal and Clay.—In 1938 when test drillings were made preparatory to opening the New Albany Coal Company's strip mine on the Lower Kittanning coal in Sections 17 and 18 of Green Township, Mahoning County, the promoters were surprised to discover a second coal lying almost directly beneath the Lower Kittanning coal in that area. The local miners had various names and numbers for this lower coal, but it is without question the Lawrence coal, the normal position of which is several feet below the Lower Kittanning coal.[6] This Lawrence coal is present as a thin, impure, and irregular bed with a discontinuous distribution in the northeastern portion of the Lisbon quadrangle. It may be more commonly present than is usually suspected. I have made no systematic effort to locate all known localities of occurrence within the area, but a number have come to my attention.

The Lawrence coal is present in the previously described sections on the Ewing and Unger farms and in the Coy and Pascola shafts Orton mentions three sections in which the Lawrence coal is present in addition to the Ewing locality.[7] It is well exposed in the New Albany Coal Company's strip mine mentioned above, where J. O. Fuller and I determined the following composite section along the face of the mine and in a drainage ditch in 1941:

19.	Glacial till		10′	0″
18.	Shale: brown, arenaceous, exposed		6′	0″
17.	Sandstone: light gray, medium to coarse, micaceous, bedded		4′	6″
16.	Sandstone: lens of bluish gray, quartzitic-appearing sandstone, with disconformable and conglomeratic base that has pebbles of local origin; grades laterally and upward into above sandstone, thickness variable		1′	6″
15.	Shale: dark gray, pyritiferous		2′	0″
14.	Shale: dark gray, fossiliferous; with few clay ironstone concretions	*Hamden*	6′	0″
13.	Shale: dark gray, fossiliferous; with nodular fossiliferous limestone at top		0′	10″
12.	Shale: black, bony, fossiliferous		1′	6″
11.	Coal: with partings of marcasite and fusain	*Lower Kittanning*	2′	8″
10.	Coal: impure, with much marcasite and fusain		0′	3″
9.	Clay: gray to dark gray, plastic		1′	6″
8.	Coal: impure; with much marcasite and fusain	*Lawrence*	1′	4″
7.	Shale: dark gray, carbonaceous, with streaks of marcasite and coal, weathers yielding sulphur		0′	4″
6.	Clay: light gray, plastic, arenaceous, especially in lower part		4′	6″
5.	Sandstone: white weathering buff, fine, micaceous, thin-bedded		2′	0″
4.	Shale: dark gray, micaceous, arenaceous; with thin layers of sandstone and apparently grading laterally into sandstone		7′	0″
3.	Sandstone: light gray, platy, micaceous, carbonaceous, irregularly bedded		11′	0″
2.	Shale and sandstone: gray to dark bluish gray, micaceous, arenaceous and carbonaceous shale with irregular layers and lenses of shaly, micaceous, and carbonaceous sandstone, thickness variable		5′	0″
1.	Sandstone: gray weathering yellowish, medium, micaceous, massive, exposed		3′	0″

---

[6] Bownocker, J. A., and Dean, E. S.: *Op. Cit.*, chart opp. p. 6 and p. 53.

[7] Orton, Ed.: *Op. cit.*, pp. 32, 33, 180, and 194.

The strata in this strip mine are irregular. There is an apparent dip of seven degrees in the beds exposed along the drainage ditch. The Lower Kittanning coal rises and falls as much as 30 feet in distances of 200 feet in the mine. The coal has thickness up to 42 inches in the swamps but only averages about 18 inches and may even run out on the swells. The Hamden member is considerably thicker and much more massive appearing in the swamps.

The Lower Kittanning and Lawrence coals can be seen in similar relationship along Route 62 in the road cut in New Albany. The localities of Lower Kittanning and Lawrence coals cited by Orton are in the now abandoned Pettit mine at Cook's Crossing one mile north of Greenford in Section 11, Green Township, and at the now abandoned Walters mine in Section 35, Green Township, Mahoning County.[8] At both places he believed that the upper coal was the Canfield cannel coal which he correlated as the Upper Clarion or Scrub Grass member and that the lower coal was the Clarion member. He was correct in correlating the upper coal with the Canfield cannel coal which is now known to be the Lower Kittanning coal, and the lower coal is now named the Lawrence coal. The limestone overlying the upper coal which Orton believed to be the Ferriferous or Vanport, is, of course, the Hamden member. Orton was undoubtedly led astray in his very logical interpretation by several facts, viz.: (1) the strongly undulatory character of the Lower Kittanning coal in the New Albany, Greenford, and Cook's Crossing areas where it rises and falls 30 feet at least in a horizontal distance of a couple of hundred feet, (2) the local absence of the Lawrence coal, (3) and the lack of knowledge at that time that fossiliferous marine limestone and shale of the Hamden member overlie the Lower Kittanning coal in this area. He believed that he recognized the Lower Kittanning coal in the old Reichstadt mine near Greenford in Section 23, Green Township, Mahoning County, where the thickness of 2½ feet of bituminous coal is overlaid by 4 to 6 inches of cannel coal. My latest studies have showed that the Reichstadt coal is probably the Middle Kittanning coal.[9] This feature of a small thickness of cannel coal overlying a considerable thickness of bituminous coal is also true for Lower Kittanning coal at several localities northward from Greenford. Orton reported this to be the condition in the Pettit mine at Cook's Crossing in Section 11, Green Township and at the Ewing mine in the southwest corner of Canfield Township, Mahoning County.[10] A similar relationship is present at places in the now abandoned G. D. Coy shaft in the southeastern corner of Section 16, Green Township, as shown in one of the previous sections and as reported by Lamborn.[11] In the southeastern quarter of Section 9, Green Township, the same relationship can be seen in the following section of the Lower Kittanning coal exposed in 1932 at the entrance of an abandoned mine:

6.	Shale: dark, weathered, exposed		2′ 0″
5.	Shale: gray to black, bony		0′ 6″
4.	Shale: gray to black, fossiliferous	*Hamden*	1′ 6″
3.	Shale: black, bony, fossiliferous (?)		0′ 7″
2.	Coal: cannel	*Lower Kittanning*	0′ 4″
1.	Coal: bituminous		3′ 8″

It should be noted that the nodular limestone of the Hamden member is absent in this section, but such absence occurs at other localities in this general area. The coal is somewhat thicker than average.

---

[8] *Idem.*, pp. 32–33 and 180–181.

[9] Sturgeon, M. T.: *The Stratigraphy of the Middle Kittanning Coal between Greenford and Washingtonville, Ohio* (in preparation).

[10] Orton, Ed.: *Op. cit.*, pp. 31 and 32.

[11] Lamborn, R. E.: *The Coal Beds in Southeastern Mahoning County*, Geol. Surv. Ohio, 4th series, Bull. 43, p. 30. (1942.)

These several sections indicate that northward from Greenford the Lower Kittanning coal grades into the Canfield cannel coal.

The Lawrence coal is also represented in the section exposed at the entrance of the abandoned Silver Creek mine and in the nearby creek in the northwest quarter, Section 21, Green Township, Mahoning County:

8.	Shale: dark gray, fossiliferous with large nodules of fossiliferous limestone, weathered	*Hamden*	1′ 3″
7.	Shale: black, bony, fossiliferous		1′ 1″
6.	Coal: with many large flattened concretions of marcasite, *Lower Kittanning*		3′ 0″
5.	Clay: gray to dark gray or black, carbonaceous and shaly		1′ 2″
4.	Coal: good	*Lawrence*	1′ 2″
3.	Coal: impure, bony; with numerous plant fossils		0′ 2″
2.	Shale: dark gray, carbonaceous, with very thin lenses of coal		0′ 10″
1.	Clay: light gray, plastic, arenaceous, exposed		1′ 0″

The above section is not only similar to the section in the New Albany Coal Company's mine but also to those cited below by Orton.

There are probably numerous other localities at which the Lawrence coal is present, but most of them are not known first hand to me. At a small mine opening to the Lower Kittanning coal in the west-central part, Section 28, Green Township, Mahoning County, there are a few inches of Lawrence coal in the clay underlying the Lower Kittanning coal. In a shaft mine located in the northeast quarter of Section 15, Salem Township, the clay underlying the Lower Kittanning coal is reported by Mr. Francis Snyder to have a thin parting of coal. About five miles further south at Robbinsville (now Coleman), Orton found in the Rock Hill mine 20 inches of poor coal four feet below the Lower Kittanning coal.[12] Stout and Lamborn quote this section from Orton in their report on the geology of Columbiana County as the section in the old shaft along Middle Fork of Little Beaver Creek about one-half mile above Teegarden, but I am sure that it is the section in the old Maurer mine near Coleman.[13] There are three reasons for this belief: (1) Orton wrote that the mine is entered by a slope, the coal lying at and below the level of low water in the creek. Above Teegarden it is the Middle Kittanning coal that is at creek level, and the mine there to the Lower Kittanning coal was a shaft. (2) Robbinsville is the old name for Coleman. (3) Orton mentioned a destructive gas explosion in this mine, and Mr. David Reese, of Logtown, recently described to me a destructive gas explosion of many years ago in the Maurer mine in which 12 miners were killed.

Stout and Lamborn did not discuss the Lawrence coal separately in their report on the geology of Columbiana County, but they did give sections in their discussion of the Lower Kittanning clay in which the Lawrence coal and its associated clay are present and recognized. The localities given by them are in St. Clair and Yellow Creek Townships and just over the boundary line in Pennsylvania.[14] They also quoted Orton's previously cited section showing Lower Kittanning and Lawrence coals in the Rock Hill mine near Coleman and printed a picture showing the same coals along Yellow Creek near New Salisbury in Section 33, Yellow Creek Township.[15]

---

[12] Orton, Ed.: *Op. cit.*, pp. 194–195.

[13] Stout, W., and Lamborn, R. E.: *Op. cit.*, pp. 104–105.

[14] *Idem.*, pp. 78, 79, and 84.

[15] *Idem.*, p. 105 and Plate III, opp. p. 184.

From all the known evidences the Lawrence coal has a wide but a somewhat discontinuous distribution in the northeastern quarter of the Lisbon quadrangle. It is generally thin and of very poor quality, being shaly and at some places pyritiferous as well. It has been prospected locally but to my knowledge has never been mined to any large extent. Its principal value is to the stratigrapher for correlation purposes.

	Number of Localities	Member	Description	Thickness
12		*Hamden*	Shale: gray, marine, argillaceous, fossiliferous	4′ 0″
11			Shale: gray to gray-black, marine, calcareous, fossiliferous; with nodular fossiliferous limestone, locally with cone-in-cone	0′ 10″
10			Shale: black, marine or brackish, bony, fossiliferous	0′ 8″
9	30	*Lower Kittanning*	Coal: with some marcasite and fusain	3′ 0″
8	8*		Clay: gray to dark gray, plastic	2′ 6″
7	8*	*Lawrence*	Coal: impure, locally absent	1′ 8″
6	2		Clay: gray, plastic, arenaceous	7′ 9″
5	4		Shale and sandstone, variable	25±′
4	4	*Vanport*	Shale: gray to dark gray, marine, variable, fossiliferous; with nodules and layers of shaly fossiliferous limestone	10±′
3	6	*Clarion*	Coal: at most places of poor quality, locally absent	1′ 4″
2	1		Clay: gray or buff stained, plastic, arenaceous	5′ 10″
1	3		Shale and sandstone	

*Used measurements from three localities given by Ed. Orton, Geol. Surv. Ohio, vol. V, pp. 33, 180, and 195. (1884.)

Fig. 5. Generalized section of exposed strata in the northeastern quarter of the Lisbon quadrangle below the Hamden shale and limestone.

SUMMARY

A composite and complete stratigraphic section of the rocks exposed below the Hamden member is given in Figure 5. The Lower Kittanning coal and overlying Hamden limestone are steady in their association and occurrence and uniform in their lithology. Hence these members are usually quite reliable but unfortunately not infallible guides in determining the stratigraphy. The last statement must be qualified because the Vanport member at two different places (see Weingart and Kenreigh sections) has nodular fossiliferous limestone in fossiliferous shale above the Clarion coal. Such a section of the Vanport and Clarion members could very easily be mistaken for the Hamden and Lower Kittanning members. The following criteria will, I believe, when fully and carefully applied, distinguish the two groups from each other: (1) The Clarion coal averages only one-half or less of the thickness of the Lower Kittanning coal. (2) The black, bony shale or "draw slate" is poorly developed or absent above the Clarion coal. (3) The assemblage of fossils is somewhat different in the two marine members. Briefly the main faunal differences appear to be:

HAMDEN MEMBER:	VANPORT MEMBER:
1. Brachiopoda:	1. Brachiopoda:
a. *Mesolobus mesolobus* var. *euampygus*—very abundant.	a. *Mesolobus mesolobus* var. *euampygus* (?)—rare.
b. Large productids: *Dictyoclostus, Linoproductus, Juresania*—rare.	b. Large productids: *Dictyoclostus, Linoproductus, Juresania*—abundant.
c. *Marginifera murcatina*—very abundant.	c. *Marginifera murcatina* (?) — very abundant.
d. *Neospirifer cameratus*—very rare.	d. *Neospirifer cameratus*—abundant.
2. Pelecypoda: Various common genera abundant.	2. Pelecypoda: Various common genera abundant.
3. Gastropoda: Various common genera abundant.	3. Gastropoda: Various common genera very abundant.
4. Cephalopoda: Various common nautiloid genera fairly abundant; ammonoid genera rare.	4. Cephalopoda: Various common nautiloid genera fairly abundant; ammonoid genera rare.
5. Crinoidea: Stems absent.[14]	5. Crinoidea: Stems rare to moderately abundant.

The close association of the Lawrence coal with the Lower Kittanning coal can be used at some places as an aid in identifying the strata in question.

The economic value of all members described with the exception of the Lower Kittanning coal and clay and the Lawrence clay is negligible.

BIBLIOGRAPHY

1. **Bownocker, J. A.,** and **Dean, E. S.** *Analyses of the Coals of Ohio*, Geol. Surv. Ohio, 4th series, Bull. 34, 1929.
2. **Lamb, G. F.** *Pennsylvanian Limestones of Northeastern Ohio below the Lower Kittanning Coal*, Ohio Naturalist, vol. 10, 1910.
3. **Lamborn, R. E.** *The Coal Beds in Southeastern Mahoning County*, Geol. Surv. Ohio, 4th series, Bull. 43, 1942.
4. **Newberry, J. S.** *Report on the Geology of Mahoning County*, Geol. Surv. of Ohio, vol. III, 1878.
5. **Orton, Ed.** *The Stratigraphical Order of the Lower Coal Measures of Ohio* and *The Coal Seams of the Lower Coal Measures of Ohio*, Geol. Surv. Ohio, vol. V, 1884.
6. **Stout, W.,** and **Lamborn, R. E.** *Geology of Columbiana County*, Geol. Surv. Ohio, 4th series, Bull. 28, 1924.
7. **Sturgeon, M. T.** *The Stratigraphy of the Middle Kittanning Coal between Greenford and Washingtonville, Ohio* (in preparation).

---

[14] Recently (May, 1943), after eleven years of intermittent collecting from the Hamden member, I collected two crinoid segments from that member at the Pascola shaft in Section 33, Green Township, Mahoning County.

Useful Plants

About two years ago Mr. van Dersal produced a book on shrubs. Highly acclaimed both for its style and its illustrations, it gave to gardeners more than a local view. It attempted to cover the country and within its scope did an amazingly good job. This reviewer is similarly impressed with this new book. In presenting his own version of economic botany to classes, something of the same sequences of topics has been used for many years by the reviewer of this book, namely, the background of the original patterns of vegetational distribution as the setting for agricultural practices. Superb photographs are lavishly employed. The general reader cannot afford to miss this book.—*A. E. Waller.*

The American Land, by William R. van Dersal. 215+xvi pp.; 64 plates. Oxford University Press, New York. $3.75.

A NEW GENUS (ASCIUS) AND TWO NEW SPECIES OF LEAFHOPPERS CLOSELY RELATED TO FLEXAMIA

(HOMOPTERA, CICADELLIDAE)

DWIGHT M. DeLONG,
The Ohio State University

Recent collecting in Mexico has brought to light large numbers of two rather common species of grass feeding leafhoppers closely related to species of *Flexamia*. Neither of these is apparently described and they do not seem to belong to *Flexamia*. A new genus is therefore being erected to include them at this time.

Genus **Ascius** n. g.

Closely related to *Flexamia* and with a similar superficial appearance. The most striking difference is the presence of a distinct keel or carina extending from the margin of vertex half the length of the face. The vertex margin is thin and foliaceous either side of apex formed by the deep concavity between the keel and the vertex margin. In lateral view the apex of the vertex appears thick margined due to the carina. The vertex is long and distinctly concave between the raised sharp edged margins. Venation of elytra similar to *Flexamia* with the reflexed costal veinlets. Type of genitalia similar to *Flexamia*.

Genotype **Ascius triangularis** n. sp.

All type material is in the author's collection.

Ascius triangularis n. sp.

In general appearance resembling a sharp headed species of *Flexamia*. Length 5 mm.

Vertex strongly produced, twice as long at middle as basal width between the eyes, more than one-third longer than pronotum. Disc of vertex concave, margins thin, foliaceous on either side. Face with a broad sharp carina extending from apex of vertex to middle of face. Elytra with one cross nervure between the claval veins and with costal reflexed veins.

Color: White with yellowish and brownish stripes. Anterior half of vertex white with faint markings either side of apex. Posterior half striped longitudinally. There is a proximal pair of broad white stripes and a narrower white stripe either side. There are five broad, longitudinal white stripes on pronotum, each bordered with brown. The scutellum has two broad white longitudinal stripes separated by the median third which is darker. The elytra are pale and irregularly marked with dark brown pigment. The white areas are so arranged that the elytra appear striped obliquely. The area along the claval vein is rather broadly white and an area between the costa and discal cell is almost entirely white. Face dark brown with a white spot just beneath apex, mottled with brown and a white longitudinal stripe on face at ventral end of keel.

Genitalia: Female last ventral segment with posterior margins broadly roundedly produced to a central broad sunken tooth which is slightly notched at middle. An underlying membrane either side is produced beyond the last ventral segment. Male valve produced, triangular, a little wider at base than median length. Plates exceeding valve by about one-half their length, broad, with blunt rounded apices. Style rather short, widened at middle, apical portion narrowed to form a short blunt finger-like process which curves outwardly. Aedeagus with a single basal portion, divided at half its length, forming a pair of long divergent processes which are heavy at base, widely separated by a U-shaped notch and tapered to slender pointed apices. A dorsal process similar in shape but much more slender extends from near base to the anal tube.

Holotype male, allotype female and male paratypes collected at Iguala, Gro., Mexico, September 11, 1939, by C. C. Plummer and the author and October 25, 1941, by E. E. Good and the author. They occur upon herbaceous vegetation.

Ascius latus n. sp.

In form and general appearance resembling *triangularis* but with vertex broad and short and face with a slightly raised keel. Length 5–5.5 mm.

Vertex broad, one-fourth longer on middle than basal width between eyes, slightly longer than pronotum. Disc of vertex shallowly broadly concave, keel of face scarcely produced and visible only at apex.

Color: Similar to *triangularis*, white with yellowish and brownish stripes. Vertex with apical third white, basal portion brown with a faint median white line and a pair of longitudinal proximal pale stripes either side near middle. Pronotum with seven pale longitudinal stripes each bordered with dark brown. Scutellum with a pale longitudinal stripe either side of median third which is brown, basal angles darker brown. Elytra white, veins brown. Claval area, disc, claval area at anterior portion of anteapical cells and apical margin marked with dark brown. Face brown with pale irrorations, white just beneath margin at apex.

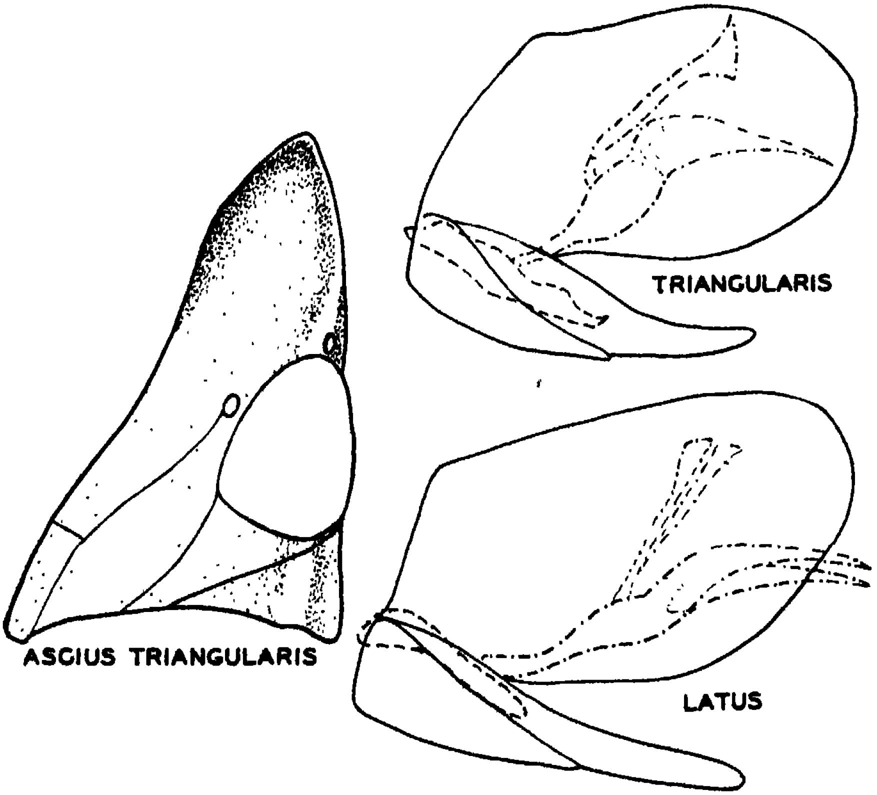


Fig. 1. Lateral view of head of *Ascius triangularis* (left); lateral view of genitalia of males of each species as labeled (right).

Genitalia: Male valve triangular, broader at base than median length. Plates triangular, broad at base, sloping to narrow, blunt, rounded apices. Style rather long and narrow with a rounded notch on outer margin just before apex forming an outwardly curved pointed finger-like process on inner margin. Aedeagus in general appearance similar to that of *triangularis* but shorter and broader. The single basal portion divides to form a pair of divergent processes which are heavy at base and taper to slender apices.

Although the genitalia of this and the former species are quite similar in structure, they are different, and externally the two species are quite different in structure.

Holotype male and paratype males collected at Iguala, Gro., Mexico, September 11, 1938, by C. C. Plummer and the author and October 25, 1941, by E. E. Good and the author.

A PORTABLE CASE FOR WATER ANALYSIS IN ECOLOGICAL FIELD WORK

WILLIAM A. DREYER,
University of Cincinnati

In ecological field work including the measurement of various physical conditions of the environment, the convenient transportation of equipment is always an important consideration, particularly when the analysis of natural waters is involved. The portable case described here was designed to carry the glassware and solutions used in the Winkler method for dissolved oxygen, a modified Seyler method for carbonates and free carbon dioxide and the colorimetric method for determination of pH. It was planned also to make possible analysis of water samples in the field permitting immediate calculation of results. The design is based upon the experience of carrying on such work with classes in elementary ecology and with graduate students engaged in the study of pond, stream and marine littoral communities. (Dreyer, 1940; Dreyer and Castle, 1941; King, Jos. E., 1943; King, Willis, 1934, and Ward, 1940.) Acknowledgment is made herewith of the accumulated suggestions of numerous students and co-workers. While not claiming complete originality of design the author presents this description to promote the more widespread use of such field equipment in ecological work of both the classroom and research level.

CONSTRUCTION AND INTERNAL ARRANGEMENT

The case itself is a wooden box, made of one-half inch clear white pine, measuring 33 x 18 x 9 inches. It consists of two parts, the body of the box (6 inches deep) and the lid (3 inches deep), which are hinged at one end with three two-inch iron hinges and held securely in place when closed by two three-inch barrel bolts and a small clasp with a hook fastener at the other end. All the joints are made with flat-head screws set flush with the surface. The 33 x 18 inch sides are reinforced with 3 x 16 inch strips set crosswise four and one-half inches from each end.

Heavy one-inch leather straps, screwed to the reinforcing strips on each side and buckled when the case is closed to form about 18-inch loops, serve as handles. The case is conveniently carried by two people with the 18-inch dimension upright (as a large suitcase) either by using the strap loops directly as handles or by thrusting a strong pole from a seine or heavy dip net through the two loops. The dimensions of the case are such that it will stand upright on the floor behind the front seat or in the baggage compartment of any automobile of recent model. When in use the case is placed in a slightly elevated position and the lid opened to an angle of about 135 degrees. Thus, the operator may squat or sit comfortably in front of the open case with all equipment within easy reach.

The inside of the case (figure 1) is fitted with sample bottles, solutions and other glassware. In the six-inch wide compartment on the left is a two-liter dark glass bottle containing $N/40$ sodium thiosulphate.[1] It is covered with black cloth and provided with a calcium chloride tube and a glass delivery tube with screw clamp shown resting in a horizontal position along the upper shelf. The small shelf above this holds three Barnes dropping bottles containing dilute starch paste, phenolphthalein (0.5 per cent alcoholic) and methyl orange (0.05 per cent aqueous), the indicators required. On the shelf to the right are bottles for three other solutions (manganese sulphate, 480 grams, hydrous, with four molecules

---

[1] The concentrations of the solutions indicated are taken from American Public Health Association, 1936, Standard Methods of Water Analysis, Eighth Edition, New York.

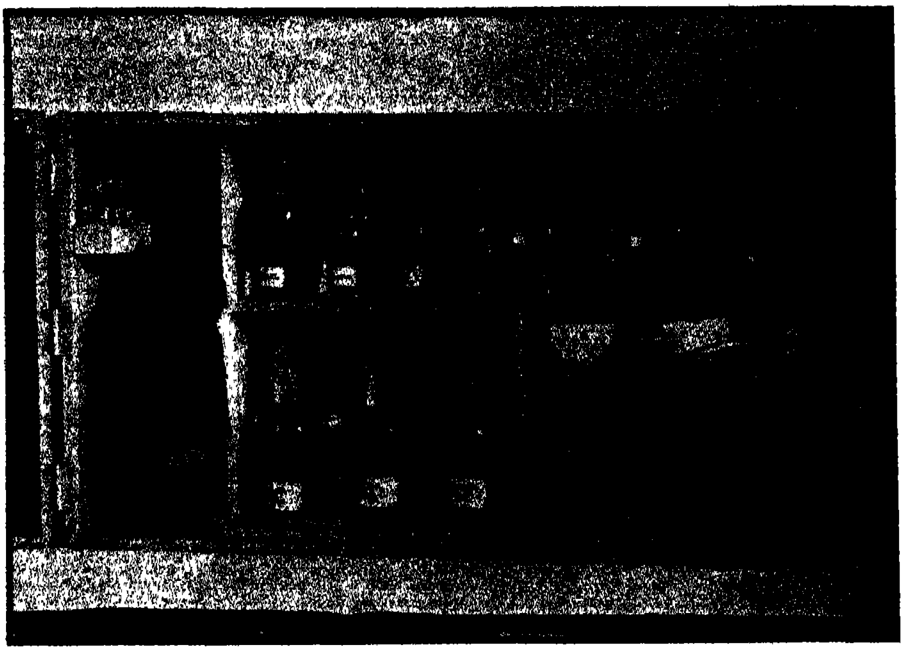


Fig. 1. Inside of the body of the case showing position of bottles and other equipment as described in the text.

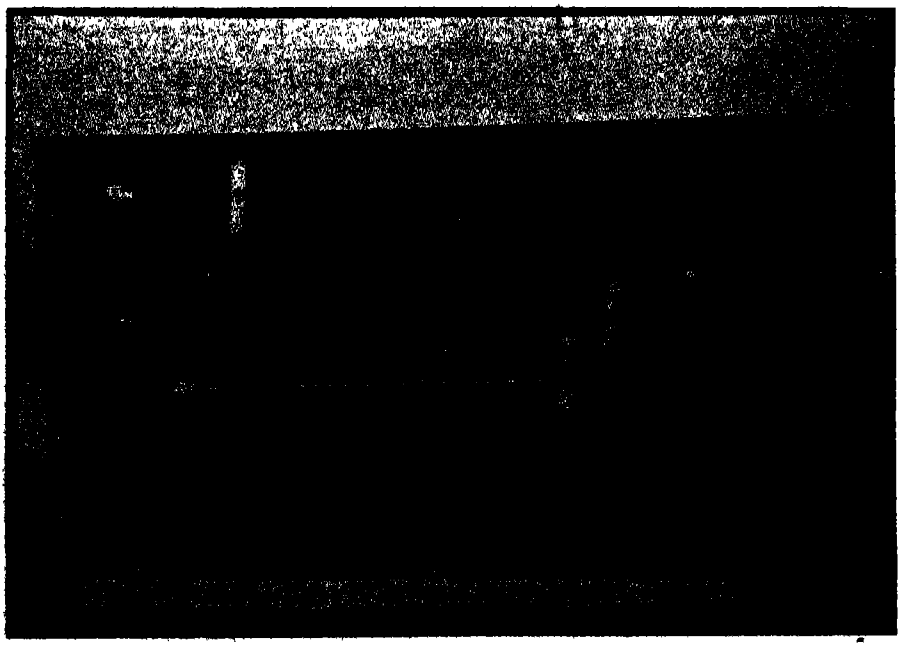


Fig. 2. Inside of the lid of the case showing position of burettes and other equipment when packed for closing the case.

of water per liter; sodium hydroxide, 500 grams, and potassium iodide, 150 grams per liter; concentrated sulphuric acid) required by the Winkler method (manganese chloride and hydrochloric acid are optional). Next, are six bottles of approximately 130 millimeters capacity labelled in pairs for duplicate water samples for oxygen determination.

Below are liter bottles of $N/50$ sulphuric acid and $N/44$ sodium hydroxide, for titration of carbonates and free carbon dioxide, and distilled water for rinsing pipettes and burettes. Next are four 250-milliliter bottles labelled in pairs for collecting water samples used in this analysis. All bottles are held in place with an ordinary web book strap laced through one inch staples properly spaced between the bottles. The labels are waterproofed with "Plicote" label glaze. In front of the lower tier of bottles are three wooden tubes holding one millimeter volumetric pipettes used for adding solutions in the Winkler method. Each tube and pipette is labelled according to the solution used to prevent contamination and mixing. Several stirring rods, towels, etc., may be carried here also. Inserted in holes bored diagonally through the shelf are three three-inch funnels suitable for pouring solutions into burettes and labelled according to the solution and burette with which each is used. Resting on the shelf below the funnels are three four-inch porcelain casseroles needed for titration of the water samples.

Inside the lid (Figure 2) are found four 50 milliliter, glass-stopcock burettes, one with a sidearm delivery tube, and two 100-milliliter volumetric pipettes which are held in place by metal finger-tip clamps covered with rubber tubing. Below is space for three La Motte block comparators of the standard six-cylinder style for colorimetric pH determination. The indicators carried can be varied according to local needs but thymol blue (9.6–8.0), phenol red (8.4–6.8) and chlor-phenol red (6.8–5.2) or brom-cresol purple (6.8–5.2) serve most requirements.

USE OF THE EQUIPMENT

When the case is to be made ready for use the block comparators are removed and the hinged strip in front of them is lowered, as shown in Figure 2, to form a shelf for the casseroles. After the burettes have been removed from the clamps the latter may be turned ninety degrees and are so placed that the burettes may be inserted in them in a vertical position. The top of the lid is hinged so that it may be lifted to permit the burettes to project above the top of the case when in position for use.

The sidearm burette, used for sodium thiosulphate, is placed in the clamps nearest the hinged end allowing the delivery tube of the solution bottle, placed on top of the box, to connect conveniently. A small calcium chloride tube is provided for the top of this burette. Two burettes are marked for use with sulphuric acid and sodium hydroxide respectively. The fourth burette is provided for titration with $N/50$ sulphuric acid to determine total acidity, when that is desired, or for titration with silver nitrate (2.725 per cent with 8 per cent potassium chromate as an indicator, Harvey, 1928) for determination of salinity in marine habitats. In that case the additional solution bottles may be placed to suit individual convenience or expediency. For example, if a wider shelf is used the funnels may be moved to the left and all the sample bottles placed in a double row to the right. Then five liter bottles may be placed in the bottom row and the casseroles stacked in the right hand end.

Two 100-millimeter pipettes are provided for measuring samples of water to be titrated so that two people may work simultaneously as is generally the case. Surface or sub-surface samples may be collected readily without bubbling with a rubber tube fitted with a double-acting aspirator bulb. This tube, not shown in Figure 1, is usually carried in the space above the two-liter bottle. The 250-milliliter sample bottles are used for the Seyler method because that size permits the titration of 100 milliliters of water with acid and another 100 milliliters from the same bottle with alkali, or the separate titration of 100 milliliters with phenolphthalein and with methyl orange indicators if that is desired when no alkali titration is required.

The preparation and use of solutions, the collection and analysis of suitable water samples and the interpretation of the methods referred to in this description are extensively discussed by Allee and Oesting (1934), American Public Health Association (1936), Birge and Juday (1911), Ellms and Beneker (1901), Harvey (1928) and Seyler (1894). The use of the concentrations indicated and samples of appropriate volume reduces the calculation of results to such simple arithmetic that it can be carried out immediately in the field. For the convenience of students who may use these directions without having available the references mentioned the following calculations are indicated. The first four are taken from American Public Health Association, 1936; the last one and the corrections for salt error in pH are from Harvey, 1928.

For oxygen in parts per million (100 ml. sample).

$$2 \times \text{ml. of } N/40 \text{ sodium thiosulphate} \times F^{n} \times F^{v}$$

F^{n} is a normality factor; F^{v} is a correction for the loss of 2 ml. of water when solutions are added to the sample bottle. Using a 130 ml. bottle, $F^{v} = 130 \div (130-2) = 1.016$.

For carbon dioxide in p. p. m. (100 ml. sample).

$$10 \times \text{ml. of } N/44 \text{ sodium hydroxide.}$$

Free carbon dioxide × 2.272 equals free carbon dioxide in terms of p. p. m. of calcium carbonate.

For phenolphthalein alkalinity in terms of p. p m. of calcium carbonate (100 ml. sample).

$$10 \times \text{ml. of } N/50 \text{ sulphuric acid.}$$

For methyl orange alkalinity in terms of p. p. m. of calcium carbonate (100 ml. sample).

$$10 \times \text{ml. of } N/50 \text{ sulphuric acid.}$$

For salinity in parts per thousand (10 ml. sample).

Salinity in p. p. t. = ml. of 2.725 per cent silver nitrate.

Corrections for salt error in pH of sea water.

Indicator	Salt Solution	pH Correction
0.04 per cent thymol blue (8.0–9.6)	.5N NaCl	—0.17
0.02 per cent phenol red (6.8–8.4)	" "	—0.15
0.04 per cent brom-cresol purple (5.2–6.8)	" "	—0.25

The advantages of using a portable case of this kind vary, of course, with the circumstances. In the case of class work the main advantage has been the assignment of the factor analysis on a particular field trip to several students who carry out that phase of the work during the first hour in the field while others collect. Later, all join the leader in locating animals that have been missed previously and in observing the numbers, activities and adaptations of organisms collected. Rotation of this assignment permits all to practice the methods without unnecessary repetition. Another obvious advantage is the availability of additional samples when one is spoiled by the carelessness or clumsiness of beginners, making it possible to have complete data in the reports of every trip. Finally, upon returning to the laboratory, the factor analysis being complete, all can take part in storing alive, preserving and examining all the specimens collected. This is especially important after an afternoon trip when time is limited.

To advanced students and working ecologists engaged in seasonal or other extended studies of the physical conditions of various habitats the advantages are those of convenience in transportation as well as speed, accuracy and completeness in obtaining results. In one instance, when a small panel truck was used for carrying camping, collecting and other field equipment, this case served as a convenient field laboratory keeping the glassware safe from jarring while in transit on rough roads and ready for use as soon as the rear of the truck was opened. Although experience with the case as described has been very satisfactory, no doubt suggestions for improvement can be made and will be welcome from any who care to submit them.

BIBLIOGRAPHY

Allee, W. C., and **Oesting, R.** 1934. A Critical Examination of Winkler's Method for Determining Dissolved Oxygen in Respiration Studies with Aquatic Animals. Physiol. Zool., 7: 509–541.

American Public Health Association. 1936. Standard Methods of Water Analysis. Eighth Edition, New York.

Birge, E. A., and **Juday, C.** 1911. Dissolved Gases of the Water and Their Biological Significance. Wisc. Geol. and Nat. Hist. Surv. Bull., 22: 13–23.

Dreyer, W. A. 1940. Ecological Conditions of the Cold Spring Harbor (New York) Sand Spit. Unpublished data.

Dreyer, W. A., and **Castle, W. A.** 1941. Occurrence of the Bay Scallop, *Pecten irradians*. Ecology, 22: 425–427.

Ellms, J. W., and **Beneker, J. C.** 1901. The Estimation of Carbonic Acid in Water. Jour. Am. Chem. Soc., 23: 405–431.

Harvey, H. W. 1928. Biological Chemistry and Physics of Sea Water. Macmillan, New York.

King, Jos. E. 1943. Survival Time of Trout in Relation to Occurrence. Am. Mid. Nat., 29: 624–642.

King, Willis. 1934. Ecological Conditions of Forest Ponds in Southwestern Ohio. Unpublished data.

Seyler, C. A. 1894. Notes on Water Analysis. Chem. News, 70: 82, 104, 112, 140, 151.

Ward, E. B. 1940. A Seasonal Population Study of Pond Entomostraca in the Cincinnati Region. Am. Mid. Nat., 23: 635–691.

Weary Plowman

A book certain to be much talked about is a small one on the subject of cultivation. The fly-leaf blurb hails it as the greatest advance of the century in scientific agriculture. Since its subject matter is not new, the exaggeration is obvious. The author does not make any such claim himself, fortunately, yet he boldly sets forth his inferences and conclusions from few or no experimental field data. He further attempts to bolster this stand by a cryptic remark about a certain noted botanist being the only scientist who could comprehend and properly appreciate his point of view. The subject matter, briefly, is concerned with using a disc harrow in place of a mold board plow. As a small book dealing seemingly with a topic of importance to food production it is most timely. But problems such as types of soil best managed by discing or plowing or costs of preparation or the results desired are somewhat lost in speculative discussions on water content of soils, mineral supplies in soils and other alleged benefits. As the crop from which the phenomenal yields are reported is the sweet potato, in which, as I understand it, the individual plants are set into place after they are four or more inches in length, any discussion of the amount of litter left on the soil after cultivation becomes somewhat academic. This book also states that the reason less organic matter accumulates as humus in forests than in prairies is because prairies are composed of annual plants. The author does not draw any further inferences from this remarkable statement.—*A. E. Waller.*

Plowman's Folly, by Edward H. Faulkner. 161 pp. University of Oklahoma Press, Norman, Oklahoma, 1943. $2.00.

SOIL CONSERVATION DISTRICTS IN OHIO[1]

T. C. KENNARD,
State Conservationist, Columbus, Ohio

For many years I have heard the statement, "The Rainbow Comes Down in Ohio." Formerly, that statement, with all it implies, gave me a sort of warm glow of pride and satisfaction. More recently, however, has come the realization that rain, usually associated with the rainbow, results in erosion. On our ability to control erosion hinges our opportunity to continue to repeat this old saying with all its implications.

I feel it a real privilege to discuss with you a job that we are all coming to realize is so vital to the welfare of every citizen in Ohio regardless of his vocation. The hour is already late. The damage already done by erosion can be realized only partially. Translated into dollars and cents, the totals would stagger us, even accustomed as we are today to figures dealing in millions and billions of dollars. Furthermore, the losses continue to mount at an ever-increasing, accelerated rate. The solution, I firmly believe, will come through an enlightened, informed public. All the more reason, then, why I feel it is so appropriate, so timely to be discussing this with you educators here today.

I understand that others have discussed certain phases of this subject with you in past sessions. At the risk of repeating part of what may have been said, I would like to present very briefly and quickly the picture as we see it today.

Of the 26,318,000 acres in Ohio, approximately 22,000,000 acres are in farms; and about 10,000,000 of these acres are cropland—that is, subject to the plow. I do not need to tell this group that every type of topography is represented in this area, from the old lake plains in the northwest to the "Switzerland of Ohio" in Monroe County. We have approximately 190 types of soils—glaciated and residual, limestone soils and soils derived from sandstone and shale; heavy soils and light soils. Type of farming varies from intensive, as illustrated by vegetable growing, to the grazing and forest farming. Even the rainfall, while fairly uniform over the state, does vary in amount, time, and intensity. I mention all of these things because every one of them has a direct effect upon this problem of soil erosion and its control, which is the primary problem of soil conservation districts.

Most of us realize that Ohio is a relatively young state agriculturally. Five years ago, Marietta celebrated its 150th birthday. Most of the state has been farmed only about 100 years. However, few of us appreciate the toll that erosion has taken in that time. Actually, we do not have the exact picture because a complete, detailed survey has never been made of the whole state. Soils men have surveyed several scattered counties completely and a few years ago made a reconnaissance survey of the whole state. This type of survey is naturally subject to considerable error, but later surveys and information lead us to believe that our estimates are too conservative—that the problem is much worse than we first thought. Even so, these figures were bad enough because they show that one-sixth of the state, or approximately 4,500,000 acres, has lost 75 percent or more of the topsoil, while about one-third of the state, or approximately 8,000,000 acres, has lost from one-fourth to three-fourths of the topsoil. Therefore, over one-half of the total area of the state has a serious erosion problem. We are now convinced that most of the remainder of the state has lost considerably more soil than the survey indicated. Even the old lake plains in northwest Ohio, where most of us would think there was little erosion, are being affected, as is evidenced by the silted streams and clogged drainage ditches—most of the latter being less than 50 years old.

---

[1] Paper presented at the annual meeting of the Geography Section of the Ohio Academy of Science, April 30, 1943, Columbus, Ohio.

All of this has a very positive and direct bearing on this soil conservation district movement. Most of us may have been blissfully ignorant of what was going on before our very eyes and literally under our own feet. We saw fields going out of cultivation. Gullies scarred our fair hillsides. We did not appreciate then that gullies represent the last stages of erosion rather than the beginning. What were once fertile farms, producing good crops, fat cattle, and fine citizens, have slipped down the scale in all respects. We saw, but we saw "as through a glass darkly."

Certainly we did not realize the full import of what was going on. These individual fields and farms began to take shape into patterns. They grew into communities, into counties, into areas. There are more of these eroded areas, and they are larger in size, than we like to admit. Some of you live in these areas. You know the situation and conditions. On the average, these areas have poorer buildings, poorer schools, poorer roads, poorer churches, and, yes, I'm afraid we'll have to admit—poorer citizens, in many cases.

Now please do not misunderstand me. I am not referring to any particular section of the state, but to those badly affected areas in all quarters of Ohio. And these conditions affect more than just the farmer making his living from the land. They have an immediate and direct effect upon the entire community—the banker, the dentist, the school teacher, the manufacturer, the auto mechanic, the motion picture man, the druggist, the insurance salesman. No single individual escapes.

Neither does the remainder of the state escape. Other sections must contribute part of their tax money for school aid in these areas. A disproportionate share of the gas tax helps maintain the roads. Old age pensions and unemployed relief take their toll also. Thus, the problem of the individual or the area becomes the problem of every citizen of Ohio regardless of who he is, where he lives, or what he does. Do not forget, too, this problem of erosion has a direct relationship to floods, to the ever-lowering water tables so important to industry and to the daily water supply of many of our cities.

As stated before, all that I have said has a direct bearing on the phenomenal growth and spread of the soil conservation district movement. I believe you will agree with me when I say it is phenomenal, when I tell you that in slightly over five years, there have been organized 841 soil conservation districts in the United States, including 490,000,000 acres of land in 42 of the 48 states.

Such a development did not "just happen." There must have been many people concerned about the problem. All they needed was direction and leadership. Probably no one has done more to focus the attention, unify the thinking, and develop the action and leadership than Dr. H. H. Bennett, Chief of the Soil Conservation Service. As a soils man he traversed this country from north to south and from ocean to ocean, always looking, always digging and boring into the ground, always thinking, talking and preaching about what was taking place. For years he was "a voice crying in the wilderness."

Finally he was heard. He was given his chance. Erosion experiment stations were set up in a number of different areas over the country. One is located at Zanesville. They told us in measured tons what was happening. They all told essentially the same story—and that story was startling indeed. Every thinking farmer and agricultural worker realized something had to be done. But what?—how?

The first answer was the demonstration project. Selected, representative areas were chosen where methods were tried out and techniques developed under actual farm conditions. They were successful to a degree but too slow in reaching the mass of farmers. Too often they were looked upon by the farmers as a "Government" project of little concern to them or their neighbors. Definitely they were not the farmers' or the community's project. And all the while, the agricultural bank account in America—the soil—was dwindling at an alarming and an ever-accelerating rate.

What to do next was the problem. Obviously, the Government could not itself control erosion on the millions of farms in the United States. Some way, somehow, the man who is responsible for causing the erosion must be made conscious of the damage he is doing; if necessary, must be made to feel a responsibility and desire to do something about it, and finally must be shown what to do and how to do it and, in some cases, actually assisted in getting it done. That man is the individual farmer.

The soil conservation district idea seems to be the best answer to the erosion problem developed to date. At least it has caught the fancy of millions of farmers to the extent that they have incorporated themselves into legally-organized, locally-controlled units, with the main purpose of individually and cooperatively solving their own problems.

The State Legislature opens the way by passing the necessary enabling legislation. By petition, and through referendum, the district is created by the farmers themselves. By petition and election they nominate and select from their own group, the men to govern and guide the district's affairs. They, the farmers in the district, study and analyze their problems, develop their programs, make their plans, and apply the practices. The soil conservation district is really and truly agricultural democracy in action.

Now what is the soil conservation district situation in Ohio? In this movement Ohio must bow its head a bit because it was the 41st state to pass the enabling act. It was passed by the last Legislature in 1941, and became a law in September of that year. The Act provides for a State Soil Conservation Committee to assist districts with their organization and in many other ways The committee is made up of the Dean of the College of Agriculture of the Ohio State University, the State Director of Agriculture, and three farmers appointed by the Governor. It began to function about February 1, 1942, and in April, 1942, the first referendum in Ohio was held in Highland County. To date eleven districts have been voted in, each covering an entire county and totaling 2,907,900 acres. They are located in the following counties: Highland, Butler, Clark, Morrow, Columbiana, Coshocton, Guernsey, Monroe, Noble, Tuscarawas, and Meigs Logan County farmers held their hearing last week (April 22) and petitions are being circulated in Fairfield County now. Several other counties are in various stages of educational activities leading to district formation.

Now let no one be misled. The fact that these districts have been organized does not mean that their erosion or soil management problems are solved or will be in the next year or two. The ills of a century cannot be cured so quickly. In fact, erosion probably will never be stopped completely. It can be slowed up, however, to the point where good soil-building practices can keep pace with the erosion losses. There doubtless are farmers living within the districts who don't even realize that a district has been organized in their county or community. Some are even opposed to and voted against them. It is *your* job and my job, and the job of a host of other people, each working in his own way, to reach these people and help do this job that is so important, so vital to each of us.

Now perhaps you would like to know in a little more detail just how these districts function and what they are doing or planning to do. Please remember that in Ohio, the oldest district is less than a year old. Even so, some tangible plans have been developed and action is under way this spring.

To get a clearer picture of the actual operations of soil conservation districts, let us examine the programs and work plans of two of the older districts in Ohio and see just what the farmers themselves say are their problems and what they propose doing about them.

First, I'd like to quote what the supervisors of the Columbiana Soil Conservation District say is the purpose of their organization.

"The Columbiana Soil Conservation District was organized for a cooperative attack upon the problems of soil and water conservation, and to improve the farming practices whereby a satisfactory farm income can be received to maintain a desirable standard of living.

"The district intends to accomplish these results through cooperative efforts of local and county-wide farm and civic organizations, state and federal agencies, county and local government, neighborhood groups, and individual farm plans and demonstrations coordinated by the district supervisors."

After then giving a general description of their area, they point to one of their basic needs as follows:

"Wide variations in soil conditions exist throughout the district and on individual farms. A detailed soil map indicating soil types, grade of slope, extent of erosion, and possible land use, is essential in order to plan a sound soil building and soil and water conservation program."

They believe that adjustments in land use are fundamental to a sound agriculture as indicated in the following section.

"There is need for adjustment in the use of land so that each acre is put to its most suitable use.

"There is need for a plan for better use of large areas of land in the district.

"1. An area consisting of 67,634 acres or 21% of the county was designated non-agricultural land by the local land use planning committee. About one-half of this area is idle, one-fourth is cropland, and one-fourth is now in timber. Of this area, 30% was tax delinquent, 20% was operated by part-time farmers, and 31% of the families were on relief, in 1939.

"2. Coal strip mining operations are rapidly taking many acres of farm land. Many of these farms can no longer adequately support families from the farm income. Community and social problems result from reduced land valuation and reduced tax income. The effect of strip mining operations on the ground water table, and the most practical use to be made of the spoil banks need consideration."

I'd like to quote further from their program.

"EROSION:

"Over half of the land recommended by the Land Use Planning Committee for agricultural use in the county has a serious erosion problem. The remainder has a moderate erosion problem. Thousands of acres in the county have already been abandoned for farming because of erosion and thousands of acres are rapidly approaching abandonment. There is a need to develop and put into operation on most of the agricultural land of the county a program of land use and approved erosion control and water conservation practices.

"WATER:

"Because of the great amount of water required for crop production, farm water supply, and industrial purposes in this area, the constant lowering of the ground water table and the heavy run-off and frequent occurrence of floods, there is a growing need to increase the water intake of agricultural and non-agricultural lands of the county. Hence, water conservation practices need to be adopted on all lands in the district.

"FARM WOODLOT MANAGEMENT AND REFORESTATION:

"The county land use study indicated that 13% of the recommended agricultural area is now in farm woodlots of which 70% is now being pastured. It further indicated that 65% of the farm buildings are over 50 years old. A farm woodlot is needed on each farm to make the needed repair and replacement of farm buildings. . . . There is need for reforestation of many acres of idle and unproductive pasture and crop land.

"WILDLIFE:

"There is a need for protection of wildlife, and to improve ground cover and increase food for wildlife."

These extracts give you a good picture of what the supervisors and farmers in the district think are some of their most important problems demanding their attention. There are many more which we will not take the time to read. Let us see what they are doing to improve the situation.

Realizing the need of more information among the farmers in the district as being fundamental to the carrying out of their plans, their first proposal is as follows:

> "EDUCATION:
>
> "The district supervisors will foster an educational program designed to carry out the purposes and the programs of the district. The program will include meetings, newspaper publicity, demonstrations, tours, addresses, discussions, and other devices for informing farmers and the general public as to the problems outlined herein, and the solutions of those problems. . . . "

To obtain the necessary soils information, the supervisors have requested that:

> "The Ohio Agricultural Experiment Station and the Soil Conservation Service, cooperating, make a soil survey of the entire district to be completed at the earliest practical date, and to make the soil maps and information available for immediate use in initiating and developing sound soil building and soil and water conservation practices. The supervisors will suggest the order of areas to be surveyed on the basis of interest and development within the district; and will use the maps to present land conditions, problems, and recommended programs to groups of farmers and to individual farmers."

To help with the technical planning:

> "The district supervisors will request that the Soil Conservation Service furnish trained men to develop plans for soil and water conservation and to assist farmers in adopting these plans. They further request the services of the specialists of the Ohio Agricultural Extension Service in developing various phases of the district program and in carrying on educational work within the district."

The job of deciding what is needed on each farm, how to do it, and then fitting these plans into the farm operations, is the most difficult part of the whole program. With a soil survey map as the basis, the supervisors request and coordinate the assistance of just as many farmers, specialists, and agencies as possible, such as the Soil Conservation Service, the Extension Service, FSA supervisors, farm organizations, vocational agricultural teachers, AAA committeemen, county commissioners, township trustees, and others.

Most districts request the Soil Conservation Service to furnish assistance in helping develop conservation plans for farms and showing methods of application. The farmer himself applies the plan to his own land for the most part. Occasionally, when his problems tie in directly as part of a neighborhood problem, such as a large drainage ditch, his neighbors, the township trustees, highway department, and perhaps others, may all pool their efforts under the general guidance of the supervisors. I'd like to quote what they say about farm planning.

> "It is intended that the principal part of the farm planning for erosion control and water conservation will be done by the group approach. An attempt will be made to get farmers with similar problems and conditions together and to develop with them plans for their farms.
>
> "A farm plan will consist of as nearly a complete farm program for soil and water conservation as is possible. It will include adjustments to secure the best use of each acre, soil building practices, liming, rotations and cropping practices, conservation practices such as contour cultivation, contour strip cropping, sod waterways and water diversions, drainage systems, water supply systems, pasture management and improvement, woodlot management and reforestation, and a suggested balance between livestock and crops. It may also include farm power and labor adjustments and other factors of farm management which will increase farm income and improve family living."

We will not take the time to go into as much detail with the Clark County District. Somewhat the same general idea is indicated in their program, although expressed in a different manner and dealing, of course, with what they consider are their problems. They, like the Columbiana folks, feel the need of basic soil information and have requested a similar soil survey. I might add that both of these surveys are well along toward completion, the information being indicated on aerial photographs with individual pictures of his farm furnished to each cooperating farmer.

The Clark County District supervisors list three major objectives:

> "(1) To conserve and build the soil. (2) To study and improve the water table. (3) To promote soil-saving agriculture that will maintain or better the farmers' standard of living."

They list eleven major problems; including erosion control, drainage, water supply, rotations, pasture improvement, reforestation and woodlot management, and farm tenancy.

These supervisors apparently believe in taking their own medicine because in the calendar they set up for farm planning they listed their own farms first. These, by the way, were planned last fall and are being put into operation this spring. They then listed the AAA Community Committeemen, followed by FSA clients. After these are planned, other planning groups will be arranged according to interest and requests as fast as they can be worked out.

In studying their district, they recognized four major areas: (1) Level to undulating, (2) undulating to gently rolling, (3) gently rolling to rolling, and (4) rolling to steep. With this classification as a basis, they then decided upon practice recommendations for the cropland, pastureland, and woodland. For example, on cropland in areas 3 and 4, which include their rolling lands, the recommend strip cropping on all slopes over 100 feet long. They think all natural drainageways should be kept in sod. For their woodlands they are recommending trees for all steep and eroded areas, protection from fire and livestock, improvement cuttings, and sound management.

I hope this partial review of the programs and work of these two districts may give you a clearer picture of what soil conservation districts are for and how they operate. You might say they are soil and water conservation cooperatives. Their goal is to secure the maximum production for each acre, indefinitely.

There is nothing particularly new or mysterious about soil conservation. It is just good common sense applied to the management of land. By nature, every acre is best adapted to a certain use. Our job is, first, to get each acre classified into its proper use; and, second, to get applied to each acre the necessary management practices.

Over 5,000 farmers in Ohio are already farming the "Conservation" way. They were cooperators with the old demonstration projects and CCC camps. They are trying these practices on their own farms and are finding them practical. What is particularly important right now is that they are finding that the application of some of these practices increases their crop production by 5, 10, or 25 percent, or more. Thus, contrary to the experiences of the last war, they can increase food production, which is so badly needed, and still have their farms in a good productive condition after the war is over.

Even with approximately one-ninth of the state already organized in soil conservation districts, the job is barely begun. To do all we believe must be done, every farm in these districts and in other districts to come, must apply those practices necessary to insure a permanent, prosperous agriculture. It's a big job—a tremendously important job. We need your help—*whoever* you are, or *wherever* you are. To get the job done will require "The everlastin' teamwork of every bloomin' soul." Then we can say again, with pride and assurance, "The Rainbow Comes Down in Ohio."

BUCKEYE LAKE WHITE BASS

LEE S. ROACH
Section of Fish Management,
Ohio Division of Conservation and Natural Resources,
Columbus, Ohio

White bass (*Lepibema chrysops*) made up more than fifteen percent of all fish caught by trap nets over a twelve month period (1939–1940) from Buckeye Lake. Calculations based on catch records from these nets indicate that there were over eighty-eight tons of these fish, beyond their first summer, in the Lake. Since this species made up less than one percent of the catch of anglers (sports or recreation fisherman) it seems wise, at this time of national emergency, to examine its growth, in Buckeye Lake, with reference to use as a supplemental meat food.

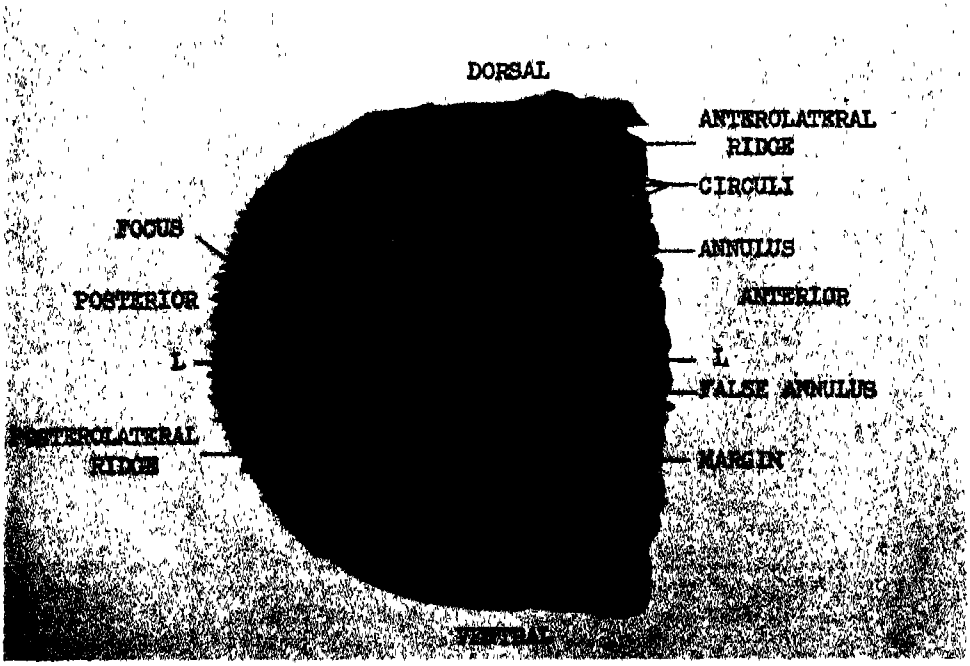


FIG. 1. White bass scale showing the main features, including a true annulus and a false annulus. This scale was taken from a seven-inch fish (total length) on June 17, 1939.

YEAR CLASSES

In as much as each fish caught by the nets was measured, curves of the length of predominating groups were prepared. These curves were very illuminating. They exhibited three nodes indicating three year classes of fish of a size that could be retained by our nets. Samples of smaller fish were very difficult to obtain by seining because they apparently roam through open water and do not inhabit shallow shores as do most of our other game species. The rapid movement of the two larger nodes (year classes) to the right during the summer, however, indicated that this species had a fast growth and that there was probably but one year class that was not captured by our nets and that group consisted of the hatch of the year. From September, 1939, on, part of this group was caught by our nets.

Analyses of several hundred scales (taken from the fish as they were caught and measured), considering the annulus formation as indicating one completed year's growth, confirmed the assumption made from length frequencies (Figure 1). Thus Buckeye Lake white bass are primarily a three-year fish with a few hardy individuals living into their fourth summer (or occasionally longer).

Evidence shows that there is a decrease in numbers each successive year, possibly due to the hazards of life such as predators but apparently many of the fish die of old age. Boat livery men, particularly Mr. Bob Donaldson, relate that weak and dead white bass are seen in the early spring drifting in the waters of the east end of the Lake where they are not normally found, and of course, many of those that die sink to the bottom or are eaten by turtles and other scavengers and are therefore not seen in numbers. We have, then, a species of fish that appears to reach a physiological limit in its life cycle at around its fourth year.

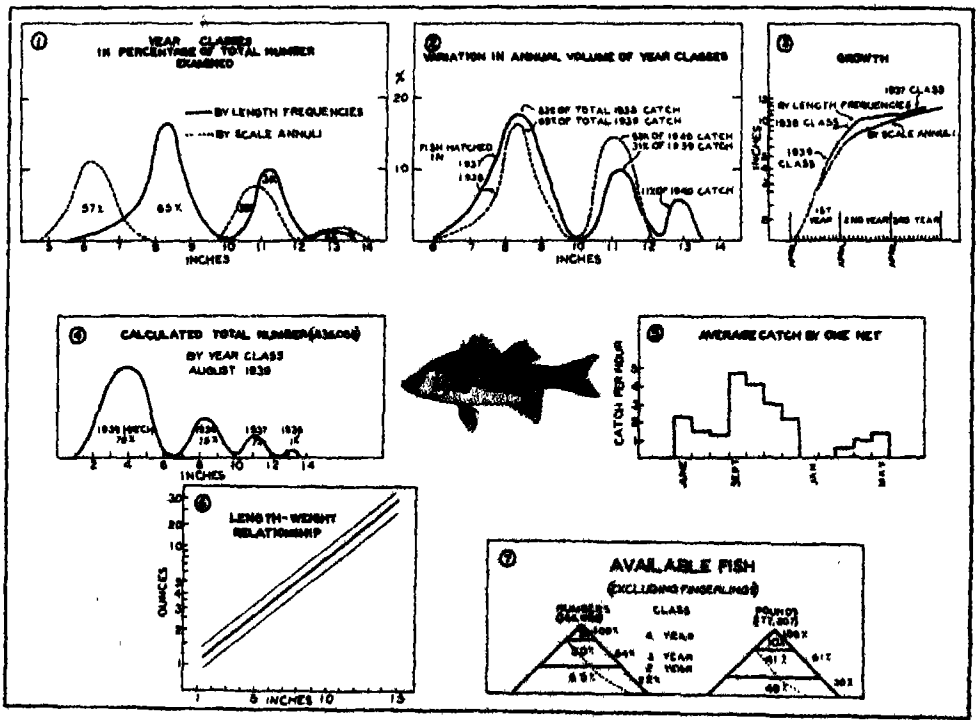


FIG. 2. Growth curves of individuals and distribution of the total white bass population in Buckeye Lake. Details of graphs are referred to in the text.

This is an unusual situation in that most species of wildlife are not believed to complete their life span through physiological deterioration, because of the violence of the natural hazards surrounding their every day activities.

This was reported before the American Fisheries Society at Toronto in September, 1940, and briefly mentioned in the Ohio Journal of Science later (Roach, 1942). These data appear with Figure 2 as Graph 1.

VARIATION IN VOLUME OF YEAR CLASSES

The numbers of white bass in a certain year class may vary somewhat from year to year depending on several factors, particularly success of spawning, availability of food, population pressure, climatic conditions and the size and numbers of other predaceous fish.

Graph 2 portrays this point and shows that fish hatched in 1937 made up 83 percent of the total catch in 1938 (second year class), 31 percent in 1939 (third year class), and 11 percent in 1940 (fourth year class); whereas fish hatched in 1938 made up only 63 percent of the second year class (1939), but 53 percent of the third year class (1940).

GROWTH

Graph 3 was prepared to show the growth of white bass as calculated from measurements between annuli on the scales and as determined by the length measurements made in the field in 1939 and 1940. The close correlation is striking. One would naturally assume some variations due to yearly food, climatic and population differences, particularly in the smaller fish. This graph indicates that, on an average, white bass reach a length of nearly six inches their first year, nearly ten inches their second year and approach twelve to fourteen inches their third year. The near absence of fish beyond fourteen inches is worth mentioning.

TOTAL NUMBER

The total number of white bass in Buckeye Lake was calculated from catch and recatch records using the formulae developed by Illinois and Wisconsin fisherines biologists and reported by Schnabel in 1938.[1]

From these calculations there appeared to be 1,636,088 white bass in Buckeye Lake in late July or early August, 1939. Graph 4 shows these in their respective year groups (as calculated in percentages of the second, third and fourth year classes after determining the normal curve of the second year class).

Examination of these data indicates that with 100 young of the year there were 21 yearlings, nine two-year-olds and one three-year-old.

MOVEMENTS

Fisherman catch many white bass from Buckeye Lake in the early spring when they are apparently spawning or feeding on gizzard shad (*Dorosoma cepedianum*) spawn along the steep sided north bank.

Catch records of our net (set at considerable distance from the north bank) indicate that we missed the major spring movement. However, for the Lake as a whole (Graph 5) the movement of white bass decreased as summer progressed, increased tremendously in the autumn and gradually decreased with the approach of winter. No white bass were taken under the ice sheet which covered the Lake in January and February, 1940.

AVAILABLE FISH

Graph 7 has been prepared to show the number of white bass present above the fingerling (first summer) stage. With this is another showing the weight of white

---

[1] $$N = \frac{\Sigma \, Mi \, Di}{R} \text{ or } \frac{\Sigma \, Mi \, Ti}{R}$$

where Mi = the total number of fish tagged in the lake when fishing *ith* time
Di = New fishes caught untagged *ith* time
ri = recatches *ith* time
$Ti = Di + ri$ = total caught *ith* time
$R = \Sigma \, ri$.

bass in each year class (this latter pyramid was prepared by using length weight conversion tables from which graph 6 was constructed). The data are from the same source as Graph 4.

Examination of these pyramids indicates that more than 386,000 white bass weighing 177,000 pounds (nearly 89 tons), all of yearling age or over, were present in Buckeye Lake in late July, 1939.

If trap nets of the same mesh size as our test nets were used to harvest white bass, catch control insuring an adequate surviving brood stock would be comparatively simple. For example, if all the fourth summer fish were removed by these nets and the other year classes were caught in proportion to their numbers in the Lake, 54 percent of the third summer fish and 22 percent of the second summer fish would be taken. This would average a removal of 40 percent of all adult fish from the Lake (53 percent by weight), leaving around 231,000 breeders in the water. This brood stock plus young of the year should be more than adequate to repopulate the Lake by the following fishing season. (Thompson and Bennett, 1938).

If evidence arises to the effect that an overtake occurs and depopulation is imminent, reduction or curtailment of take could be easily made. In any event 46 tons of white bass or any portion thereof should be a worthwhile addition to the central Ohio meat supply.

LITERATURE CITED

Roach, Lee S. 1942. Fish Population of Buckeye Lake as Determined by Trap Nets. Ohio Jour. Sci. 42: 237-245.

Schnabel, Zoe Emily. 1938. The Estimation of the Total Fish Population of a Lake. Amer. Math. Monthly, 45: June-July.

Thompson, David H. and George W. Bennett. 1938. Lake Management Reports. 1. Horshoe Lake Near Cairo, Illinois. Biological Notes No. 8, Illinois Natural History Survey.

Milk Sickness

Dr. Moseley, in his book "Milk Sickness Caused by White Snakeroot," has presented material which he has collected on the subject for a period of over forty years, including his discovery of the causative agent, White Snakeroot. History of the scourge of milk sickness in pioneer days, experimental evidence as to the causative agent, symptoms of the illness in farm animals, laboratory animals and man, medical treatment and description, illustrations and distribution of White Snakeroot, are subjects which make up most of the volume. The book will be of value and interest to medical men, veterinarians, agriculturists, historians, and botanists.—*G. W. B.*

Milk Sickness Caused by White Snakeroot, by Edwin Lincoln Moseley. 171 pp. Lithographed. Published jointly by The Ohio Academy of Science and the author. 1941. $1.00. A copy will be sent to any member of The Ohio Academy of Science without cost. To obtain a copy, write to Mrs. Ethel M. Miller, Librarian, Botany and Zoology Bldg., The Ohio State University, Columbus, Ohio.

World Trade in Agricultural Products

It is remarkable to have compressed within a single volume so much information on a large and important subject. The review of agricultural export and import during the years between World Wars I and II gives us a picture of our present situation and possible guidance for the future. Agricultural trade not only shows us the peaceful ways of balancing illogical distribution, but points to backgrounds of conflict. This volume has a high measure of reliability since the basic data are from the International Institute of Agriculture at Rome and our own United States Department of Agriculture. It is an indispensable handy reference for any one interested in a world view of agriculture. Topics covered in the chapters include cotton, wool, silk, rubber, tobacco, coffee, tea, sugar, wheat, rice, meats, fats and oils.—*A. E. Waller.*

World Trade in Agricultural Products, by Henry C. Taylor and Anne Dewees Taylor. 286 pp., 23 charts, 18 maps, 59 statistical tables. The Macmillan Co., New York, 1943. $3.50.

RECORDS OF OHIO DRAGONFLIES

B. ELWOOD MONTGOMERY,
Purdue University, West Lafayette, Ind.

During the past few years a large number of Ohio records of dragonflies have been accumulated from collections received for determination and from personal collecting within the state. These include numerous new county records and one species new to the Ohio list. All of the specimens were identified by the author except one specimen each of ***Epiaeschna heros*** and ***Perithemis tenera*** and a series of 40 specimens of ***Anax junius***, the records of which were furnished by Homer F. Price.

All of the records from Defiance, Mercer, Paulding, Putnam and Williams counties are based upon collections made by Homer F. Price of Payne, Ohio. The greater part of these collections were made in Paulding County throughout the 1942 season, although a few were obtained in the latter part of the summer of 1941. Localities listed for Paulding County include Flatrock, Marie DeLarme and Blue Creeks, the Auglaize River at Fort Brown, the Maumee River in Crane Township and gravel pits in Benton and Paulding Townships. Mr. Price's collections from the other counties were made during 1942, as follows: Defiance—Auglaize River near power dam, May 24, June 15, July 7, 27 and 31; Auglaize River near Defiance, July 27; Maumee River near Independence Dam, July 7; Mercer—Grand Lake, July 4; Grand Reservoir, July 22; St. Mary's River, July 4 and 7; Putnam—Auglaize River east of Cloverdale, June 28; Williams—Nettle Lake and St. Joseph River, June 22. As all of these collections represent new county records they are given, with such notes and comments as seem of interest, in the list below.

One of the specimens collected by Mr. Price belongs to a species (*Somatochlora linearis* Hagen) not previously reported from Ohio. This species has a range covering the eastern half of the country; there are records for most of the states from Quebec and Maine to Georgia, and for Missouri, Illinois and Indiana In Indiana it has been found to be rather abundant locally, mostly along woodland streams, or in neighboring open glades and roadways through the forests (Montgomery, 1934, 1941). The most recent paper on Ohio Odonata (Borror and Epstein, 1942) gives the number of species known from the state as 132, and the present addition brings this number to 133.

Records from Erie, Marion and Ottawa counties were compiled from collections made by Robert P. Mullett. The Erie County collections were made in the vicinity of Sandusky from April to July, those from Marion at Durfee's Lake, Marion, June 9, and the Whitstone River at King's Mill, July 15, and that from Ottawa on South Bass Island, August 6—all during 1942. The South Bass Island collection included specimens of ***Neotetrum pulchellum***, ***Pachydiplax longipennis***, ***Argia apicalis***, ***A. moesta***, ***Enallagma carunculatum***, ***E. ebrium***, ***E. exsulans***, ***E. hageni***, and ***Ischnura verticalis*** This date, August 6, extends the known seasonal range in Ohio of ***E. ebrium*** and ***E. hageni***, the latest previous records being July 15 and July 10, respectively. On April 30, at the Sandusky city dump, Mr. Mullett found females of ***Ischnura verticalis*** ovipositing and "observed one female laying eggs in a cattail stem under water for three minutes and ten seconds.". ***Anax junius*** was taken here on the same date and later in the season 14 other species—***Gomphus spicatus***, ***Perithemis tenera***, ***Holotania luctuosa***, ***Plathemis lydia***, ***N. pulchellum***, ***Sympetrum obtrusum***, ***S. rubicundulum***, ***P. longipennis***, ***Erythemis simplicicollis***, ***Tramea lacerata***, ***Lestes disjunctus***, ***A. apicalis***, ***Enallagma anten-***

natum and *E. exsulans*—were taken at the same habitat and/or in an adjacent quarry.

The Portage County records were obtained from a small collection made near Garrettsville in 1936 by William Thrasher and sent in exchange for specimens of Coleoptera.

The Darke County specimens were collected along Greenville Creek, two to five miles southeast of Union City, June 26, 1942, by E. Phillips Blackburn and the author.

The Butler County records are the results of two visits to the campus of Western College at Oxford to obtain specimens of *Archilestes grandis* Rambur. A collecting party consisting of Lynn Robertson, Jr., Marshall B. McDonald and the author, made a brief stop August 24, 1939, en route home from a collecting trip to the Southeast (Montgomery, 1940), and the author, accompanied by his wife and daughter, spent a short time here October 6, 1940. The creek on the Western College campus has been described by Williamson (1930) in his account of the capture of *grandis* here, September 25 and October 11, 1927—the first record of this species northeast of Oklahoma. In 1939 we found this creek very low, only a trickle of water through the culvert in the dam below the pool and only scant cupfuls here and there among the broken pieces of limestone in the creek bed below the dam. In 1940 there was even less water and the pool above the dam was reduced in size with some mud flats exposed around its margin. No individuals of *A. grandis* were seen around or above the pool where Williamson found them comparatively abundant in 1927, but a few males—one in 1939, two in 1940—were seen and captured in the creek bed below the dam. In 1939 we found several other species of dragonflies around the pool—swarms of *Erythemis simplicicollis* and *Ischnura verticalis*, considerable numbers of *Pachydiplax longipennis* and *Enallagma civile*, and occasional individuals of *Plathemis lydia*, *Hololania luctuosa*, *Tramea lacerata* (tenerals), *Lestes rectangularis* and *Ischnura posita*. In 1940 the season was quite late at the time of our visit and dragonflies, except Sympetrum, were rather rare. The specimens of Sympetrum captured included *obtrusum*—3 ♂, *rubicundulum*—1 ♂, and *vicinum*—11 ♂, 5 ♀. The other specimens taken were *Aeshna umbrosa*—1 ♀, *Lestes congener*—5 ♂, *Enallagma civile*—1 ♂, and *Ischnura verticalis*—1 ♂, 3 ♀. The presence of *A. grandis* in the same habitat after an interval of 13 years indicates that it has established itself more or less permanently in this region.

Only a few representative and especially interesting specimens from the collections determined for Homer F. Price and Robert P. Mullett were retained for the collection of the author, the remainder were returned to the collectors. The 1939 specimens from Butler County were sent to the Museum of Zoology at the University of Michigan. All other specimens are in the collection of the author.

In the following list the species are numbered according to Borror's 1937 and 1938 lists and the records are given by counties. However, interesting observations, dates extending the known seasonal range for Ohio (these dates are starred*), and further information on specimens of rare or unusual species are included and additional collection data are given for records of specimens not included in the collections described above.

4. *Ophiogomphus rupinsulensis* (Walsh). Ashtabula—1 ♂, Geneva, *August 4, 1940, A. L. Burhanna.

8. *Gomphus crassus* Hagen. Defiance—Auglaize River, June 15 and *July 7.

10. *Gomphus fraternus* (Say). Putnam.

12 *Gomphus graslinellus* Walsh. Defiance—Auglaize River, June 15, July 7; Paulding—Flatrock Creek, June 5, July 2, 14, and *27.

25. *Dromogomphus spoliatus* (Hagen). Defiance, Paulding—Auglaize River at power dam and near Fort Brown, *June 21 to *July 31.

31. *Anax junius* (Drury). Mercer, Paulding. Mr. Price sent records of about 40 specimens of this species taken in Paulding County from September 5 to October 8, 1942, with a note that "several attempts were made after October 8 to take specimens, but none were seen."

34. *Epiaeschna heros* (Fabricius). Paulding—1♀, May 6, 1942, "found nearly dead on screen on cold morning by Dorothy Wood."

36. *Aeshna constricta* Say. Paulding.

38. *Aeshna umbrosa* Walker. Portage.

42. *Cordulegaster obliquus* (Say). Portage—1 ♂, May 29, 1936.

45. *Macromia taeniolata* Rambur. Defiance—1 ♂, July 27, and 3 ♂, July 31, Auglaize River near power dam. Two of these specimens vary somewhat from the characteristics listed for this species by Williamson (1909) towards those of *wabashensis*—keel of second tibia approximately one-third of length of tibia (keel 3.5 mm., length of tibia 11 mm.), a single dorsal yellow spot on segment 8, and lateral yellow spots on frons. Also a female taken along the Auglaize River at Fort Brown, Paulding County, June 21, 1942, does not belong to this species, but as the specimen is somewhat teneral its specific position is difficult to determine. These specimens, along with a considerable number from other sources, are being held for further study as there is much need for a thorough revision of the North American species of Macromia.

*133. *Somatochlora linearis* (Hagen). Paulding—1 ♂, Flatrock Creek, August 3, 1941. This is an addition to the Ohio list.

54. *Perithemis tenera* (Say). Mercer, Paulding.

64. *Holotania luctuosa* (Burmeister). Paulding, Williams.

65. *Plathemis lydia* (Drury). Defiance, Paulding, Williams.

66. *Neotetrum pulchellum* (Drury). Defiance, Williams.

68. *Eolibellula semifasciata* (Burmeister). Paulding.

70. *Sympetrum ambiguum* (Rambur). Paulding—1 ♂, along open ditch at edge of woodlot, *October 4. "Three heavy frosts before this date." *Sympetrum vicinum* and *Lestes disjunctus* were also taken on this date.

72. *Sympetrum obtrusum* (Hagen). Butler, Williams.

73. *Sympetrum rubicundulum* (Say). Defiance, Mercer, Paulding, Williams. *May 5 to *October 6.

76. *Sympetrum vicinum* (Hagen). Paulding.

77. *Leucorrhinia intacta* (Hagen). Marion.

78. *Pachydiplex longipennis* (Burmeister). Defiance, Marion, Mercer, Paulding.

79. *Erythemis simplicollis* (Say). Butler, Williams.

81. *Pantala hymenaea* (Say). Paulding—1 ♀, *September 19.

82. *Tramea carolina* (Linnaeus). Marion, Paulding. June 9, *September 14 Mr. Price noted on September 14, that "the Trameas were rather common around the yard and orchard today. There was a stiff breeze and the Trameas hunted in the lee of the trees and rested well up on the higher branches where I could not get at them."

83. *Tramea lacerata* Hagen. Paulding.

87. *Calopteryx maculatum* (Beauvois). Darke, Paulding, Williams.

88. *Hetaerina americana* (Fabricius). Darke, Putnam.

91. *Lestes congener* Hagen. Butler.

92. *Lestes disjunctus* Selys. Defiance, Marion, Mercer, Paulding. May 12 to *October 4.

96. *Lestes rectangularis* Say. Mercer, Paulding, Williams.

97. *Lestes dryas* Kirby. (Listed by Borror as *L. uncatus* Kirby, but Cowley, 1935, has shown that this name is a synonym.) Mercer, Paulding. *June 5 to July 14.

98. *Lestes unguiculatus* Hagen. Paulding.

100. *Argia apicalis* (Say). Defiance, Marion, Mercer, Paulding, Putnam.

102. *Argia moesta* (Hagen). Defiance, Marion.

104. *Argia tibialis* (Rambur). Darke, Marion, Mercer, Williams.

105. *Argia violacea* (Hagen). Darke, Paulding, Williams.

106. *Amphiagrion saucium* (Burmeister). Williams.

110. *Enallagma antennatum* (Say). Paulding.

128. *Enallagma basidens* Calvert. Paulding. June 15 to August 2.
113. *Enallagma carunculatum* Morse. Darke.
114. *Enallagma civile* (Hagen). Defiance, Paulding.
118. *Enallagma exsulans* (Hagen). Darke, Defiance, Marion, Paulding. *May 14 to August 7.
121. *Enallagma signatum* (Hagen). Darke, Paulding, Williams.
124. *Ischnura posita* (Hagen). Marion, Paulding.
126. *Ischnura verticalis* (Say). Defiance, Marion, Paulding.
127. *Anomalagrion hastatum* (Say). Darke.

LITERATURE CITED

Borror, Donald J. 1937. An annotated list of the dragonflies (Odonata) of Ohio. Ohio Journ. Sci., 37: 185–186.

1938. Additions to the Ohio list of dragonflies (Odonata). Ohio Journ. Sci., 38: 307–310.

Borror, Donald J., and **Epstein, Erwin J.** 1942. New records of Ohio dragonflies (Odonata). Ohio Journ. Sci., 42: 81–83.

Cowley, J. 1935. Remarks on the names of some British Odonata. Ent., 68: 154–156.

Montgomery, B. Elwood. 1934. Records of Indiana dragonflies—VII. 1932–1933. Proc. Ind. Acad. Sci., 43: 211–217.

1940. The Odonata of South Carolina. Journ. Elisha Mitchell Sci. Soc., 56: 283–301.

1941. Records of Indiana dragonflies—X. 1937–1940. Proc. Ind. Acad. Sci., 50: 229–241.

Williamson, Edward Bruce. 1909. The North American dragonflies of the Genus Macromia. Proc. U. S. Nat. Mus., 37: 369–298, pls. 35–36.

1930. *Archilestes grandis* (Ramb.) in Ohio (Odonata: Agrionidae). Ent. News, 42: 63–64.

Aerial Photographs

New views of our old world can bring new thoughts and, perhaps, help teach man a little more about how to live decently. Aviation gives man a new environment and a better chance to interpret familiar scenes. Mapping from aerial photographs has been shown to have practical advantages over surface surveys for certain purposes. The list of occupations in which aerial photography is becoming a useful tool is growing rapidly. Of equal importance is a knowledge of how the photographs have been made and how they are to be interpreted. Dr. Smith's book rounds out, in a satisfactory way for beginners, the many things we can learn from good photographs.—*A. E. Waller.*

Aerial Photographs and Their Applications, by H. T. U. Smith. 312 pp., many photographs. D. Appleton Century Co., New York, 1943. $3.75.

Fogs, Clouds and Aviation

The ninety-three full-page photographs of cloud forms and cloud phenomena in this little book leave only one hundred-six pages of text, index and references. But these pages are delightfully written in clear and as nearly non-technical English as is practically possible. For those possessing but an elementary knowledge of physics, the explanations of the various cloud formations help in understanding and appreciating these commonly disregarded and unappreciated natural phenomena. For the amateur meteorologist these explanations are aids in making short range weather predictions. For the aviator both in peace and wartime there are suggestions for making use of the existing clouds. He is also shown which ones to avoid. This book cannot fail to interest all those for whom the weather is more than something to grumble or exclaim about.—*Richard T. Wareham.*

Fogs, Clouds and Aviation, by W. V. Humphreys. I–XII+200 pp.; 94 full-page illustrations. The Williams and Wilkins Co., Baltimore, 1943. $3.00.

Behind the Sulfa Drugs

The readers of Dr. Galdston's essay will be interested in tracing the changes in thinking about diseases as bacteriology has advanced. Claude Bernard's dictum "That which we know frequently impedes us in acquiring new knowledge" is apropos. While we may kill bacteria outside the human body with substances like corrosive sublimate, or iodine, we are handicapped trying to use the same methods *to kill* if the organisms are inside living cells. Bacteriology and Chemotherapy overlap somewhat. Chemotherapy now augmented by the sulfa drugs and with penicillin may be said to be getting started. Readers will find that the background includes more than the decade of research that brought forth the sulfa drugs.—*A. E. Waller.*

Behind the Sulfa Drugs, by Iago Galdston, M. D. 174 pp. Appleton Century, New York, 1943.

PROTOZOAN PARASITES OF THE ORTHOPTERA, WITH SPECIAL REFERENCE TO THOSE OF OHIO

IV.[1] CLASSIFIED LIST OF THE PROTOZOAN PARASITES OF THE ORTHOPTERA OF THE WORLD.—(*Continued*)

FRANK MERRICK SEMANS
The Ohio State University
and
Youngstown College, Youngstown, Ohio

Class 4. CILIATA Perty, 1852.

Possess cilia or cirri during the trophic stage.

Order 1. HOLOTRICHIDA Delage and Hérouard, 1896.

Cilia uniformly distributed over the entire body surface. Adoral zone never present.

Family 1. *Isotrichidae* Bütschli, 1889.

Body covered by a thick pellicle. Ciliation uniform and thick. (Majority found in the mid-intestine of ruminants.)

Genus 1. **Isotricha** Stein, 1858. Body ovoid. Cytostome at anterior end or somewhat to one side.

Isotricha caulleryi Weill, 1929.
References: (1) Weill, 1929, 24.
Synonymy: Name unchanged.
Hosts: (a) *Periplaneta americana* (Linnaeus), (1).
Habitat: Alimentary canal, (1a).
Distribution: French Indo-China, (1a).

Order 2. HETEROTRICHIDA Delage and Hérouard, 1896.

Body usually covered by delicate cilia. Adoral zone, which is wound to the right (clockwise), composed of strong cilia or membranellae.

Family 1. *Plagiotomidae* Claparède and Lachmann, 1858.

Adoral zone parallel to main body axis; peristome narrow and long.

Genus 1. **Nyctotherus** Leidy, 1849. Body oval or reniform. Peristome begins a little back of anterior end of body and forms cytostome.

Nyctotherus ovalis Leidy, 1850.

References: (1) Siebold, 1839, 69; (2) Leidy, 1850, 100; (3) Leidy, 1853b, 244; (4) Leidy, 1853c, 41; (5) Stein, 1854, 42; (6) Leidy, 1856, 43; (7) Stein, 1856, 36; (8) Claparède and Lachmann, 1858, 240; (9) Stein, 1859, 78, 84, 85, 90; (10) Stein, 1860, 50; (11) Stein, 1862; (12) Stein, 1867, 344; (13) Leidy, 1879, 204; (14) Grassi, 1881, 197; (15) Schuster, 1898, 244; (16) Belar, 1916, 242; (17) Zulueta, 1916, 5; (18) Kudo, 1922, 113; (19) Yakimoff and Miller, 1922a, 9; (20) Yakimoff and Miller, 1922b, 133; (21) Pinto, 1926, 14; (22) Tejera, 1926, 1382; (23) Bhatia and Gulati, 1927, 86, 113, 116; (24) Lucas, 1927b, 224, 232; (25) Lucas, 1928, 161; (26) Weill, 1929, 22; (27) McAdow, 1931, 16; (28) Balch, 1932, 237; (29) this paper, parts II and III.

Synonymy: "Leucophrys-artiges Infusorium," (1); *Nyctotherus ovalis*, (2), (3), (4), (6), (11), (12), (13), (14), (15), (16,) (17), (18), (19), (20), (21), (22), (23), (24), (25), (26), (27), (28), (29); *Bursaria blattarum* (5), (7), (9); *Plagiotoma Blattarum*, (8), (10); *Plagiotoma blattarum* (9).

Hosts: (a) *Blattella germanica* (Linnaeus), (5), (23), (27); (b) *Parcoblatta pensylvanica* (DeGeer), (29, *N. ovalis* variety?); (c) *Blatta orientalis* Linnaeus, (1), (2), (3), (4), (5), (17), (23), (24), (27); (d) *Periplaneta americana* (Linnaeus), (15), (21), (23), (25), (26), (27); (e) *Gryllotalpa gryllotalpa* Linnaeus, (28); (f) Undetermined species of wood-cockroaches, (21).

---

[1] Part I: Ohio Jour. Sci., 36: 315–320. 1936. Part II: Ohio Jour. Sci., 39: 157–181. 1939. Part III: Ohio Jour. Sci., 41: 457–464, 1941. Part IV: Ohio Jour. Sci., 43: 221–234. 1943, and continued in this issue.

Habitat: Alimentary canal, (1c), (2c), (3c), (5a), (5c), (17c), (21d), (21f), (23a), (23b), (23d); mid-intestine, (23)d; hind-intestine, (23d), (24c), (26d), (29b); colon, (15d), (27a), (27c), (27d); rectum, (27a), (27c), (27d).

Distribution: Brazil, (21d), (21f); London, England, (24c); French Indo-China, (26d); Berlin, Germany, (17c); Lahore, India, (23d); United States, (2c); Urbana, Illinois, (18c); Ohio, (27a), (27c), (27d); Champaign County, Ohio, (29b).

Family 2. *Bursariidae* Stein, 1867.

Adoral zone parallel to main body axis. Peristome wide, triangular and deep.

Genus 1. **Balantidium** Claparède and Lachmann, 1858. Body large, oval to subcylindric, slightly truncate anteriorly. Peristome medium wide and slightly oblique in direction.

Balantidium ovatum Ghosh, 1922.

References: (1) Ghosh, 1922b, 371; (2) Bhatia and Gulati, 1927, 85; (3) Weill, 1929, 22; (4) McAdow, 1931, 21.
Synonymy: Name unchanged.
Hosts: (a) *Periplaneta americana* (Linnaeus), (1), (3).
Habitat: Alimentary canal, (1a); rectum, (3a).
Distribution: French Indo-China, (3a); Calcutta, India, (1a).

Balantidium blattarum Ghosh, 1922.

References: (1) Ghosh, 1922a, 15; (2) Bhatia and Gulati, 1927, 85; (3) McAdow, 1931, 21.
Synonymy: Name unchanged.
Hosts: (a) *Periplaneta americana* (Linnaeus), (1).
Habitat: Alimentary canal, (1a).
Distribution: Calcutta, India, (1a).

LITERATURE CITED IN PARTS I TO IV OF THIS SERIES OF PAPERS

Balbiani, G. 1884. Leçons sur les sporozoaires. Paris. (Les grégarines, 1–68, 170.)

Balch, H. E. 1932. The cultivation of *Nyctotherus ovalis* and *Endamoeba blattae*. Science, 76: 237.

Belar, K. 1916. Protozoenstudien 2. Arch. Protistenk., 36: 241–302.

Bhatia, B. L. 1930. Synopsis of the genera and classification of the haplocyte gregarines. Parasitology, 22: 156–167.

Bhatia, B. L., and **Gulati, A. N.** 1927. On some parasitic ciliates from Indian frogs, toads, earthworms and cockroaches. Arch. Protistenk., 57: 85–120.

Bhatia, B. L., and **Setna, S.** 1924. On some new cephaline gregarines. Parasitology, 16: 279–288.

Bishop, A. 1931. A description of *Embadomonas* n. spp. from *Blatta orientalis*, . . . , Parasitology, 23: 286–300.

Brindley, H. H. 1918. Notes on certain parasites, food, and capture by birds of the common earwig (*Forficula auricularia*). Proc. Cambridge Phil. Soc., 19: 167–177.

Brindley, H. H., and **Potts, F. A.** 1910. The effects of parasitic castration in insects. Science, 32: 836.

Bush, S. F. 1928. A study on the gregarines of the grasshoppers of Pietermaritzburg, Natal. Ann. Natal Mus. Pietermaritzburg, 6: 97–169.

Bütschli, O. 1878. Beiträge zur Kenntniss der Flagellaten und einiger verwandten Organismen. Zeitschr. f. Wiss. Zool., 30: 205–281.

1881. Kleine Beiträge zur Kenntniss der Gregarinen. Zeitschr. f. Wiss. Zool., 35: 384–409.

Caullery, M., and **Mesnil, F.** 1901. Le parasitisme intracellulaire et la multiplication asexuee des gregarines. C. R. Soc. Biol. Paris, 53: 84–87.

1905. Recherches sur les haplosporidies. Arch. Zool. Exp. et Gen., Ser. 4, 4: 101–181.

Claparède, E., and **Lachmann, J.** 1858. Études sur les infusoires et les rhizopodes. Mem. Inst. Nat. Genev., 5: 1–260.

Comstock, J. H. 1930. An introduction to entomology. Rev'd. ed. Comstock Pub. Co., Ithaca, N. Y.

Crawley, H. 1903a. List of the polycystid gregarines of the United States. Proc. Acad. Nat. Sci. Phila., 55: 41–58.

1903b. The polycystid gregarines of the United States (second contribution). Proc. Acad. Nat. Sci. Phila., 55: 632–644.

1905. *Coelosporidium blattellae*, new sporozoan parasite of *Blattella germanica*. Proc. Acad. Nat. Sci. Phila., 57: 158–161.

1907. The polycystid gregarines of the United States (third contribution). Proc. Acad. Nat. Sci. Phila., 59: 220–228.

Cuénot, L. 1894. Défense de l'organisme contre les parasites chez les insectes. C. R. Acad. Sci. Paris, 119: 806–808.

1895. Études physiologiques sur les orthoptères. Arch. Biol., 14: 293–341.

1897a. Évolution des grégarines coelomiques du grillon domestique. C. R. Acad. Sci. Paris, 125: 52–54.

1897b. Double emplois du nom de genre *Diplocystis* parmi les protozoaires. Zool. Anz., 20: 209–210.

1901. Recherches sur l'évolution et la conjugasion des grégarines. Arch. Biol., 17: 581–652.

Desmarest, E. 1845. *Gregarina*. Dictionnaire universel d'histoire naturelle, D'Orbigny, 6: 317.

Diesing, C. M. (same as K. M.) 1851. Systema helminthum, 2.

1859. Revision der Rhyngodeen. Anz. Akad. Wiss. Wien. Sitzungsb., 37: 719–782.

Doflein, F. 1901. Die Protozoen als Parasiten und Krankheitserreger nach biologischen Gesichtspunkten dargestellt. G. Fischer, Jena.

1909. Lehrbuch der Protozoenkunde. G. Fischer, Jena.

1929. Lehrbuch der Protozoenkunde. 5th ed. rev'd. by Reichenow. Jena.

Dogiel, V. 1909. Beiträge zur Kenntnis der Gregarinen. (3) Über die Sporocysten der Coelom-Monocystideae. Arch. Protistenk., 16: 194–208.

Dufour, L. 1828. Note sur la grégarine, nouveau genre de ver qui vit en troupeau dans les intéstins de divers insects. Ann. Sci. Nat., Ser. 1, 13: 366–368.

1837. Recherches sur quelques entozoaires et larves parasités des insects orthoptères et hymenoptères. Ann. Sci. Nat., Ser. 2, 7: 5–20.

Dujardin, F. 1845. Histoire naturelle des helminthes ou vers intestinaux. (Appendice 1, 637–639.)

Ellis, M. M. 1913a. New gregarines from the United States. Zool. Anz., 41: 462–465.

1913b. Gregarines from some Michigan Orthoptera. Zool. Anz., 43: 78–84.

1913c. A descriptive list of the cephaline gregarines of the new world. Trans. Amer. Micr. Soc., 32: 259–296.

Elmassian, M. 1909. Sur l'*Amoeba blattae*. Arch. Protistenk., 16: 143–163.

Epstein, H. 1911. Beiträge zur Kenntniss von *Pleistophora periplanetae* (Lutz and Splendore). Biol. Zentralbl., 31: 676–682.

Fantham, H. B. 1923. Some parasitic Protozoa found in South Africa, VI. S. African Jour. Sci., 20: 493–500.

1924. Some parasitic Protozoa found in South Africa, VII. S. African Jour. Sci., 21: 435–444.

1925. Some parasitic Protozoa found in South Africa, VIII. S. African Jour. Sci., 22: 346–354.

1929. Some parasitic Protozoa found in South Africa. (XII). S. African Jour. Sci., 26: 386–395.

Frantzius, A. v. 1848. Einige nachträgliche Bemerkungen über Gregarinen. Arch. Naturgesch., 14: 188–196.

1846. Observationes quaedam de gregarinis. Diss. inaug. 8, 35 pp. Berolini. (Not available in the original. Taken from Wellmer, 1911).

? Observ. q. d. Gregarinis II. 23 et 28. (Not available in the original. Taken from Diesing, 1851.)

Frenzel, J. 1892. Über einige argentinische gregarinen. Jena Zeitschr. Naturw., 27: 233–336.

Geiman, Q. M. 1932. The intestinal protozoa of the larvae of the crane fly, *Tipula abdominalis*. Jour. Parasit., 19: 173.

Georgévitch, J. 1925a. Sur la structure de la spore de *Pleistophora periplanetae*. C. R. Acad. Sci. Paris, 181: 1191–1194.

1925b. Sur le cycle évolutif de *Pleistophora periplanetae*. C. R. Acad. Sci. Paris, 182: 102–104.

1927. Recherches sur *Pleistophora periplanetae* Lutz et Splend. Arch. Zool. Exp. et Gen., 66: 1–21.

Ghosh, E. 1922a. On a new ciliate, *Balantidium blattarum* sp. nov., intestinal parasite in the common cockroach (*Blatta americana*). Parasitology, 14: 15–16.

1922b. On a new ciliate, *Balantidium ovatum* sp. nov., an intestinal parasite in the common cockroach (*Blatta americana*). Parasitology, 14: 371.

Grassi, B. 1879. Dei protozoi parassiti e specialmente di quelli che sono nell' uomo. Gazzetta Medica Italiana Lombarda, 39: 445–448.

1881. Intorno ad alcuni protisti endoparassitici ed appartenenti alle classi dei flagellati, lobosi, sporozoi e ciliati. Atti Soc. Ital. Sci. Nat. Mus. Civ. Milano, 24: 135–224.

Hall, M. C. 1907. A study of some gregarines with especial reference to *Hirmocystis rigida* n. sp. Univ. Studies, Univ. Nebraska, 7: 149–174.

Hamburger, C. 1912. Über einige parasitische Flagellaten. Verh. Naturh.-Med. Ver. Heidelberg, 11: 211–219.

Imms, A. D. 1929. A general textbook of entomology. 2nd ed. rev'd. Methuen & Co. Ltd., London.

Jameson, A. P. 1920. The chromosome cycle of gregarines, with special reference to *Diplocystis schneideri* Kunstler, 1887. Quart. Jour. Micr. Sci., 64: 207–266.

Janicki, C. 1908. Contribuzione alla conoscenza di alcuni protozoi parassiti della *Periplaneta orientalis* (*Lophomonas blattarum* Stein, . . .). Rend. Accad. Lincei, Ser. 5, 17: 140–151.

1909. Über Kern und Kernteilung bei *Entamoeba blattae* Bütschli. Biol. Zentralbl., 29: 381–393.

1910. Untersuchungen an parasitischen Flagellaten. I. Teil. . . . Zeitschr. f. Wiss. Zool., 95: 243–315.

Kamm, M. W. 1920. The development of gregarines and their relation to the host tissues: (3) in *Gregarina rigida* (Hall) Ellis. Jour. Parasit., 7: 23–28.

1922a. A list of new gregarines described from 1911 to 1920. Trans. Amer. Micr. Soc., 41: 122–152.

1922b. Studies on gregarines II. Illinois Biol. Monog., 7, No. 1: 1–104.

Kent, W. S. 1880–1882. A manual of the Infusoria. 3 vols. David Bogue, London.

Kudo, R. 1922. The parasitic Protozoa of *Blatta orientalis* and their value as the material for use in a class of parasitic Protozoa. Anat. Rec., 23: 113.

1924. A biologic and taxonomic study of the Microsporidia. Illinois Biol. Monog., 9, Nos. 2 and 3: 7–268.

1926a. Observation on *Lophomonas blattarum*, a flagellate inhabiting the colon of the cockroach *Blatta orientalis*. Arch. Protistenk., 53: 191–214.

1926b. Observations on *Endamoeba blattae*. Amer. Jour. Hyg., 6: 139–152.

1926c. A cytological study of *Lophomonas striata* Bütschli. Arch. Protistenk., 55: 504–515.

1931. Handbook of protozoology. Bailliere, Tindall & Cox, London.

Künckel, d'Herculais, J. 1899. De la mue chez les insectes, considerée comme moyen de defense contre les parasites vegétaux ou animaux. C. R. Acad. Sci. Paris, 128: 620–622.

Kunstler, M. J. 1887. *Diplocystis schneideri* nov. gen., nov. sp. Tablettes Zoologiques, 2: 25–66.

Labbé, A. 1899. Sporozoa. Das Tierreich. 5: 1–180.

Lankester, E. R. 1863. On our present knowledge of the Gregarinidae. Quart. Jour. Micr. Sci., 3: 83–96.

Laveran, A., and **Franchini, G.** 1920a. Contribution a l'étude des flagellés des culicides, des muscides, . . . Bull. Soc. Path. Exot. Paris, 13: 138–147.

1920b. *Herpetomonas* et *Spirochaeta* de la blatte orientale. Bull. Soc. Path. Exot. Paris, 13: 331–333.

Léger, L. 1892. Recherches sur les grégarines. Tablettes Zoologiques, 3 (1 and 2).

1893. Sur une grégarine nouvelle des acridiens d'Algerie. C. R. Acad. Sci. Paris, 117: 811–813.

1897. Nouvelles recherches sur les polycystidées parasites des arthropodes terrestres. Ann. Fac. Sci. Marseille, 6.

Léger, L., and **Duboscq, O.** 1899. Notes biologiques sur les grillons. Arch. Zool. Exp. et Gen., Ser. 3, 7: Notes et Revue, 35–40.

1900. Les grégarines et l'épithélium intestinal. C. R. Acad. Sci. Paris, 130: 1566–1568.

1901. Sur les premiers stades du développement de quelques polycystidées. C. R. Acad. Sci. Paris, 133: 439–441.

1902a. Sur la régeneration épithéliale dans l'intestin moyen de quelques arthropodes. Arch. Zool. Exp. et Gen., Ser. 3, 10: Notes et Revue, 36–42.

1902b. Les grégarines et l'épithélium intestinal chez les trachéates. Arch. Parasitol., 6: 377–473.

1909. Études sur la sexualité chez les grégarines. Arch. Protistenk., 17: 19–134.

Leidy, J. 1850. Two new species of infusorial Entozoa. Proc. Acad. Nat. Sci. Phila., 5: 100.

1853a. On the organization of the genus *Gregarina* of Dufour. Trans. Amer. Phil. Soc. Phila., 10: 233–240.

1853b. Some observations on nematoidea imperfecta, and descriptions of three parasitic infusoriae. Trans. Amer. Phil. Soc. Phila., 10: 241–244.

1853c. A flora and fauna within living animals. Smithson. Contr. Knowl., 5: Article 2.

1856. A synopsis of Entozoa and some of their ectocongeners observed by the author. Proc. Acad. Nat. Sci. Phila., 8: 42–58.

1879. On *Amoeba blattae*. Proc. Acad. Nat. Sci. Phila., 1879: 204–205.

Lucas, C. L. T. 1927a. The intestinal amebae of the cockroach. Jour. Parasit., 13: 220.

1927b. Two new species of *Amoeba* found in cockroaches: with . . . Parasitology, 19: 223–235.

1928. A study of excystation in *Nyctotherus ovalis* with notes on other intestinal protozoa of the cockroach. Jour. Parasit., 14: 161–175.

Lühe, M. 1904. Bau und Entwicklung der Gregarinen. (1). Arch. Protistenk., 4: 88–198.

Lutz, A., and **Splendore, A.** 1903. Über Pebrine und verwandte Mikrosporidien. Zentralbl. Bakt. (Part 1) Originale, 33: 150–157.

McAdow, C. M. 1931. Observations on some protozoa parasitic in cockroaches. M. A. Thesis, Ohio State University, MS.

Magalhaes, P. S. de. 1900. Notes d'helminthologie brésilienne. Arch. Parasitol., 3: 34–69.

Marshall, W. S. 1893. Beiträge zur Kenntniss der Gregarinen. Arch. Naturgesch., 1: 25–44.

Mercier, L. 1906. Un organisme à forme levure parasite de la blatte (*Periplaneta orientalis* L.). Levure et *Nosema*. C. R. Soc. Biol. Paris, 58: 1081–1083.

1907. Un parasite du noyau d'*Amoeba blattae* Bütschli. C. R. Soc. Biol. Paris, 62: 1132–1134.

1908a. Neoplasie du tissu adipeux chez des blattes (*Periplaneta orientalis* L.) parasitées par une microsporidie. Arch. Protistenk., 11: 372–381.

1908b. La schizogonie simple chez *Amoeba blattae* Bütschli. C. R. Acad. Sci. Paris, 146: 942–945.

1908c. Contributions à l'étude de la sexualité chez les myxosporidies et chez les microsporidies. Mém. Acad. R. Belgique Cl. Sci., Ser. 2, 2.

1909. Le cycle évolutif d'*Amoeba blattae* Bütschli. Arch. Protistenk., 16: 164–168.

1910. Contribution à l'étude de l'amibe de la blatte (*Entamoeba blattae* Bütschli). Arch. Protistenk., 20: 143–175.

Paehler, F. 1904. Über die Morphologie, Fortpflanzung und Entwicklung von *Gregarina ovata*. Arch. Protistenk., 4: 64–87.

Parisi, B. 1910. Su alcuni flagellati endoparassiti. Arch. Protistenk., 19: 232–238.

Perrin, W. S. 1905. Preliminary communication on the life-history of *Pleistophora periplanetae* Lutz and Splendore. Proc. Cambridge Phil. Soc., 13: 204–208.

1906. Observations on the structure and life-history of *Pleistophora periplanetae* Lutz and Splendore. Quart. Jour. Micr. Sci., 49: 615–634.

Pfeiffer, L. 1893. Untersuchungen über den Krebs. Die Zellerkrankungen und die Geschwülstbildungen durch Sporozoen. G. Fischer, Jena.

Pinto, C. F. 1918a. Sobre as eugregarinas parasitas dos artropodos brasileiros. Brasil Medico, 32: 49–50; 113–114.

1918b. Estudos sobre as gregarinas. Brasil Medico, 32: 321–322.

1919. Contribuição ao estudo das gregarinas. Mem. Inst. Oswaldo Cruz.

1926. *Nyctotherus* dos blattideos do Brasil. Bol. Biol. S. Paulo, 1: 14–16.

Schaudinn, F. 1902. Beitrage zur Kenntnis der Bakterien und verwandter Organismen. Arch. Protistenk., 1: 306–343.

Schewiakoff, W. 1894. Über die Ursache der fortschreitenden Bewegung der Gregarinen. Zeitschr. f. Wiss. Zool., 58: 340–354.

Schiffman, O. 1919. Über die Fortpflanzung von *Gregarina blattarum* und *Gregarina cuneata*. Arch. Protistenk., 40: 76–96.

Schneider, A. 1873. Sur quelques points de l'histoire du genre *Gregarina*. Arch. Zool. Exp. et Gen., 2: 515–533.

1876. Contributions à l'histoire des grégarines des invertèbres de Paris et de Roscoff. Thesis, Faculté des Sciences de Paris.

1882. Seconde contribution à l'étude des grégarines. Arch. Zool. Exp. et Gen., 10: 423–450.

1885. Grégarines nouvelles ou peu connues. Tablettes Zoologiques, 1: 25–30.

1887. Grégarines nouvelles ou peu connues. Tablettes Zoologiques, 2: 67–85.

Schnitzler, H. 1905. Über die Fortpflanzung von *Clepsidrina ovata*. Arch. Protistenk., 6: 309–333.

Schubotz, H. 1905. Beiträge zur Kenntniss der *Amoeba blattae* (Bütschli) und *Amoeba proteus* (Pall.). Arch. Protistenk., 6: 1–46.

Schuster, E. H. J. 1898. On a new flagellate protozoan of the genus *Lophomonas*. Proc. Zool Soc. London, 1898: 242–244.

Semans, F. M., 1936, 1939, 1941, and 1943. See footnote, p. 271, in this paper.

Shiwago, P. 1909. Über Vermehrung bei *Pleistophora periplanetae* Lutz und Splendore. Zool. Anz., 34: 647–654.

1911. Der heutige Stand der Frage über die geschlechtlichen Vorgänge bei den Myxo- und Microsporidien. Biol. Zeitschr. Moskau, 2: 37–60.

Siebold, C. T. von. 1837. Fernere Beobachtungen über die Spermatozoen der wirbellosen Thiere. Arch. Anat. Phys. u. Wiss. Med., 1837: 381–439.

1839. Beiträge zur Naturgeschichte der wirbellosen Thiere. . . . Neuste Schr. Naturf. Ges. Danzig, 3.

Smith, L. M. 1929. *Coccospora stenopelmati* gen. nov., sp. nov., a gregarine from Stenopelmatus (Orthoptera) from central California. Univ. Cal., Pub. Zool., 33: 57–68.

1930. Further observations on the protozoan *Tettigonospora* (new name for *Coccospora* Smith, 1929). Univ. Cal., Pub. Zool., 33: 445–447.

Smith, N. M., and Barret, H. P. 1928. The cultivation of a parasitic amoeba from the cockroach. Jour. Parasit., 14: 272–273.

Sokolow, B. 1911. Liste des grégarines décrites depuis 1899. Zool. Anz., 38: 277–295, 304–314.

Stein, F. 1848. Über die Natur der Gregarinen. Arch. Anat. Phys. u. Wiss. Med., 1848: 182–223.

1854. Die Infusionsthiere auf ihre Entwickelungsgeschichte untersucht.

1856. Über die ihm bisher bekannt gewordenen und von ihm genauer erforschten Infusionsthiere, . . . Abh. Böhmisch. Ges. Wiss., Ser. 5, 10: 35–38.

1859. Der Organismus der Infusionsthiere. Abth. 1.

1860. Vortrag über die bisher unbekannt gebliebene *Leucophyrs patula* Ehbg. und über zwei neue Infusoriengattungen *Gyrocorys* und *Lophomonas*. Abh. Böhmisch. Ges. Wiss., 1: 44–50.

1862. Amtl. Ber. der Karlsbader Naturforscherver. S. 166. (Not available in the original. Taken from Stein, 1867.)

1867. Der Organismus der Infusionsthiere. Abth. 2.

Swarczewsky, B. 1914. Über den Lebenscyclus einiger Haplosporidien. Arch. Protistenk., 33: 49–108.

Taliaferro, W. H. 1928. A note on the amoeba of the cockroach cultivated by Smith and Barrett. Jour. Parasit., 14: 274.

Tejera, E. 1926. Les blattes envisagées comme agents de dissémination des germes pathogènes. C. R. Soc. Biol. Paris, 95: 1382–1384.

Thomson, J, G., and **Lucas, C. L. T.** 1926. A preliminary note on the study of *Endamoeba blattae* (Bütschli, 1878) Leidy, 1879 . . . Jour. Trop. Med. & Hyg., 29: 41–43.

Wasielewski, T. v. 1896. Sporozoenkunde. (Gregarinen, 8–36, 136–139.) Jena.

Watson, M. E. 1915. Some new gregarine parasites from Arthropoda. Jour. Parasit., 2: 27–36.

1916a. Studies on gregarines. Illinois Biol. Monog., 2, No. 3: 1–258.

1916b. Observations on polycystid gregarines from Arthropoda. Jour. Parasit., 3: 65–75.

Weill, R. 1929. Notes protistologiques indochinoises. (1). Arch. Zool. Exp. et Gen., 69, Notes et Revue: 12–37, 41–54.

Wellmer, L. 1910. Beitrag zur Kenntnis der Sporozoenfauna Ostpreussens. Zool. Anz., 35: 530–534.

1911. Sporozoen ostpreussischer Arthropoden. Schr. Phys.-ökon. Ges. Königsberg, 52: 103–164.

Wolters, M. 1891. Die Conjugation und Sporenbildung bei Gregarinen. Arch. Mikr. Anat., 37: 99–138.

Woodcock, H. M. 1904. On *Cystobia irregularis* (Minch.) and allied "neogamous" gregarines. (Preliminary note.) Arch. Zool. Exp. et Gen., Ser. 4, 2: Notes et Revue: 125–128.

Yakimoff, W. L., and **Miller, G. A.** 1922a. Les protozoaires de l'intestin de l'homme en dehors de l'organisme de l'homme. Bull. Soc. Path. Exot. Paris, 15: 8–11.

1922b. Ueber die Darmprotozoen von *Periplaneta orientalis*. (Russian with German resumé.) Russkii Arkhiv Protistologii, 1: 131–133.

Zulueta, A. de. 1916. Sobre la estructura y bipartición de *Nyctotherus ovalis* Leidy. Trab. Mus. Cienc., serie zoologica 26.

Tropical Paradise Lost

This is the story of an expedition to collect seeds from the Philippines and Netherlands India. Dr. and Mrs. David Fairchild were guests of Mrs. Anne Archbold on her Chinese junk "Cheng Ho." From January to July in 1940 they sailed among the islands of the Celebes Sea, the Bauda Sea and the Bali Sea. They traveled as far as Manila in the North to Amboina in the Southeast and Soerabaja in the Southwest. Some ports led them to old friends and one wonders, on reading this two years after Pearl Harbor, what may have become of them. The "finds" were safely returned in spite of war-time problems. As was brought out in the two previous books of Dr. Fairchild, the book is not the real end product. There are many interesting plantings growing up in many places from the materials introduced. The 125 photographs would alone make this book an excellent record of tropical plants. It is not given to many men to produce a post-autobiography; fewer still take a recall bow so gracefully.—*A. E. Waller.*

Garden Islands of the Great East, by David Fairchild. 239 pp., 125 photographs and map inside jacket. Charles Scribner's Sons, New York. 1943. $3.75.

Animal Breeding Plans

The second edition of that excellent text on animal breeding differs from the first edition principally in two chapters. The chapter "How Selection Changes a Population" has been expanded into two chapters, "How Selection Changes the Genetic Composition of a Population" and "How Selection Changes a Population—The Outward Results." The chapter on "The Family System" has been expanded and entitled "Family Structure of Populations." These changes are notable improvements in that the material is brought up to date and is also presented in a simpler manner.

This text is designed for the professional student of animal breeding, who has had courses in genetics, physiology and animal husbandry. The author has done a highly commendable job of presenting the applications of sound genetic principles to the many problems confronting the practical animal breeder. Professional animal breeders, as well as students of advanced animal husbandry, can ill afford to overlook Animal Breeding Plans.—*D. C. Rife.*

Animal Breeding Plans, Second Edition, by Jay L. Lush. The Iowa State Collegiate Press, Ames, Iowa. 1943. $3.50.

INDEX TO VOLUME XLIII

Amstutz, Mary Elizabeth, 165.
Anostracan Phyllopods in O., 176.
Anthropology, 17.
Ants of Ashtabula Co., O., 22.
Ants of Kildeer Plain, O., 165.
Ascius, 250.
Astraeospongia, n. sp., 210.

Balduf, W. V., 74.
Barrows, W. M., 209.
Bass, Growth of, 263.
Blaydes, Glenn W., 81.
Blood Groups and Hand Patterns, 182.
Buprestidae, 42.

Catalogue of Ohio Vascular Plants, 186.
Chaetonema ornatum, sp. nov., 212.
Christ, 17.
Chrysobothris paragrindeliae, n. sp., 42.
Cicada Killing Wasp, 32.
Cicadellidae, 79, 214.
Coal, 235.
Cockayne, E. A., 1.
Coleochaete sampsonii sp. nov., 213.
Coleoptera, 42.
Columbiana County, 235.
Congenital Pyloric Stenosis, 1, 49.
Cyrtocerina n. sp., 51.

Dambach, Charles A., 32.
Davidson, Ralph H., 193, 214.
DeLong, Dwight H., 79, 193, 214, 250.
Deltorynchus, new genus, 79.
Dexter, Ralph W., 176.
Draeculacephala constricta n. sp., 193.
Draeculacephala mollipes, 193.
Dreyer, William A., 252.
Drosophila Culture Medium, 174.

Earthworms, American and Oriental, 87, 99.
Ecological Field Work, 252.
Empoasca, n. sp., 212.
Euglena mutabilis, 47.

Fairy Shrimps in O., 176.
Fish Embryos, Observing, 83.
Fish, Worm Parasites of, 201.
Flexamia, 250.
Flower, Rousseau H., 51.
Formicidae, 22, 165.
Fungus hyphae, Composition of, 135.

Gates, G. E., 87, 99.
Genetics of Pyloric Stenosis, 1, 49.
Gipsy at the Crucifixion, 17.
Glaciation, pre-Illinoian, 180.
Good, Eugene, 32.
Greulach, Victor A., 65.

Hand Patterns, 182.
Hare, Robert C., 201.
Headley, A. E., 22.
Heffelfinger, John, 181.
Hemiptera, 74.
Heredity and Natural Selection, 117.
Homoptera, 79, 214.
Human Inheritance, 49.
Hymenoptera, 22, 165.

Ilex opaca, 43.
Inulin, Staining, 81.
Ipomoea, 65.
Ireland, H. A., 180.

Jones, Clyde H., 186.

Kennard, T. C., 257.
Kittanning Coal, 235.
Kloepfer, H. Warner, 182.
Knull, J. N., 42.
Krecker, Frederick H., 158.

Leafhopper, New Genus, 79.
Leafhoppers, New Species, 250.
Leech Anatomy, 198.
Lichens, Water Relations, 139.
Limestone, 235.
Linkage of Blood Groups, 182.

Mahoning County, 235.
Mahr, August C., 17.
Mastigophora, 221.
McAtee, W. L., 117.
Microtechnic, 81.
Miller, John A., 198.

Natural Selection, 117.

Ohio Acad. Sci., Ann. Rpt., 147.
Ohio Jour. Sci., publication dates, 1943, iv.
Ohio Soil Conservation, 257.
Ohio Vascular Plants, 186.
Orthoptera Protozoan Parasites, 221, 271.

Penrose, L. S., 1.
Photoperiodic Aftereffects, 65.
Photoperiodism, 65.
Phymata, Annotated List, 74.
Phymatidae, 74.
Phytophthora, 135.
Portable Case, Water Analysis, 252.
Portage Lakes Fishes, 201.
Prairie Spider, n. sp., 209.
Presidential Address, 158.
Price, John W., 83.
Publication Dates of the Ohio Journal of Science, 1943, iv.
Protozoan Parasites of Orthoptera, 221, 271.
Psoroptes cuniculi, 181.
Pyloric Stenosis, 1, 49.

Rabbit Ear Infection, 181.
Rife, D. C., 182.
Roach, Lee S., 263.

Sandusky Bay Varves, 195.
Sarcodina, 221.
Scofield, Herbert T., 139.
Semans, Frank Merrick, 221, 271.
Sheary, Leslie E., 176.
Snyder, Laurence H., 49.
Soil Conservation, 257.
Souessa nasuta n. sp., 209.
Spencer, Warren P., 174.
Sphecius speciosus, 32.
Spider, n. sp., 209.
Sporozoa, 221.
Stratigraphy, 235.
Sturgeon, Myron T., 235.
Swanson, C. A., 43.

Thomas, R. C., 135.
Transeau, Edgar N., 212.
Transpiration from Holly, 43.

Ulothricales, n. sp., 212.

Von Dach, Herman, 47.
Varves in Sandusky Bay, 195.

Water Analysis Apparatus, 252.
Wells, John W., 210.
Wilson, Ira T., 195.
Woods and Trees, 158.
Worm Parasites of Fish, 201.

Yarman, Lawrence E., 139.

THE OHIO
JOURNAL OF SCIENCE

VOLUME XLIV — 1944

GLENN W. BLAYDES, Editor-in-Chief

PUBLISHED AT COLUMBUS, OHIO, BY THE

OHIO STATE UNIVERSITY
and the
OHIO ACADEMY OF SCIENCE

CONTENTS OF VOLUME XLIV—Continued

NUMBER 5—SEPTEMBER

Page
Annual Report of the Ohio Academy of Science, 1944 193
A Unique Prehistoric Irrigation Project .... *Henry C. Shetrone* 203
The Research Fund of the Ohio Academy of Science .... *Herbert Osborn* 213
Dolomites .... *Wilber Stout* 219
A New Genus (Tenucephalus) and Species of Mexican Leaf-hopper Related to Parabolocratus .... *Dwight M. DeLong* 236
New Species of Zygnemataceae .... *Clarence E. Taft* 238
Notes on Leafhoppers with Descriptions. (Homoptera: Cicadellidae) .... *Dorothy J. Knull* 239
Notes on Zygnemataceae .... *E. N. Transeau* 243
Book Notices 218, 235, 242, 244

NUMBER 6—NOVEMBER

Studies in Hodgkin's Syndrome. I. A Distribution Study of Hodgkin's Disease in the United States .... *H. A. Hoster* 245
Notes on Some Less Common Genera of Tropical Cixiidae (Homoptera), *John S. Caldwell* 252
The History of Ohio's Northernmost Coal Mine .... *Myron T. Sturgeon* 255
Ovipositor Studies of the Leafhopper Genus Erythroneura (Homoptera: Cicadellidae), *Mary Auten Trautman* 265
Descriptions of Six Typhlocybas From the United States (Homoptera: Cicadellidae), *Dorothy J. Knull* 269
Nomanclatorial Notes on Cicadellidae .... *Dwight M. DeLong* 272
A Systematic Study of the Main Arteries in the Region of the Heart—Aves IX. Coliiformes—Part 1 .... *Fred H. Glenny* 273
Three New Zygnemataceae From Arkansas .... *Glenn C. Couch* 277
Symposium on Premedical Education 277
Review Papers:
  Penicillin: A Potent New Chematherapeutic Agent .... *Wm. G. Myers, Ph.D., M.D.* 278
Book Reviews 278, 286
Index to Volume XLIV 287

PUBLICATION DATES OF THE OHIO JOURNAL OF SCIENCE FOR 1944

January issue	**March 9**
March issue	**April 27**
May issue	**July 15**
July issue	**September 1**
September issue	**November 13**
November issue	**January 18, 1945**

THE OHIO JOURNAL OF SCIENCE

VOL. XLIV JANUARY, 1944 No. 1

CONTRIBUTIONS TO THE STRATIGRAPHY OF THE ALLEGHENY SERIES IN COLUMBIANA AND MAHONING COUNTIES, OHIO

PART II. THE STRATIGRAPHY OF THE MIDDLE KITTANNING COAL BETWEEN GREENFORD AND WASHINGTONVILLE, OHIO

MYRON T. STURGEON,
Michigan State Normal College,
Ypsilanti, Michigan

The Kopp Klay Kompany has a small plant for the manufacture of building tile at Greenford in Green Township, Mahoning County, Ohio. This plant is located about 0.6 of a mile east of the Greenford square on the south side of the road and on the west side of the Niles and Lisbon branch of the Erie Railroad. (See Figure 1.)

Formerly the clay used for making the tile came from a now abandoned mine at the plant. This mine, which was opened many years ago by Andrew Reichstadt, will be herein called the Reichstadt mine. It has long been a matter of dispute among geologists and local miners whether the clay used in this tile plant is the underclay of the Lower of Middle Kittanning coal? Some believe that it is the Lower Kittanning clay, others are equally certain that it is the Middle Kittanning clay, and still others are uncertain as to which of the Kittanning clays it is.

I talked recently with a son of Andrew Reichstadt who was able to tell me that the mine was opened about 75 years ago but was unable to give me much information concerning the mine. The oldest possible written mention of this mine and at that a very uncertain one was made in 1878 by Newberry, who wrote as follows:[1]

> "In the east part of the Township (Green), Coal No. 4 has been opened on the farms of Reichstahl and Roller but is not now worked."

It is entirely possible that Newberry misspelled the name Reichstadt and that the location mentioned is the mine in question, but the different spelling of the name and the uncertainty of the exact location are only suggestive at best. Newberry's Coal No. 4 is now known to be the Middle Kittanning coal in this vicinity.

Orton was the next geologist to visit the locality under consideration, and there is no question that the Reichstadt mine was in operation at that time. He wrote as follows:[2]

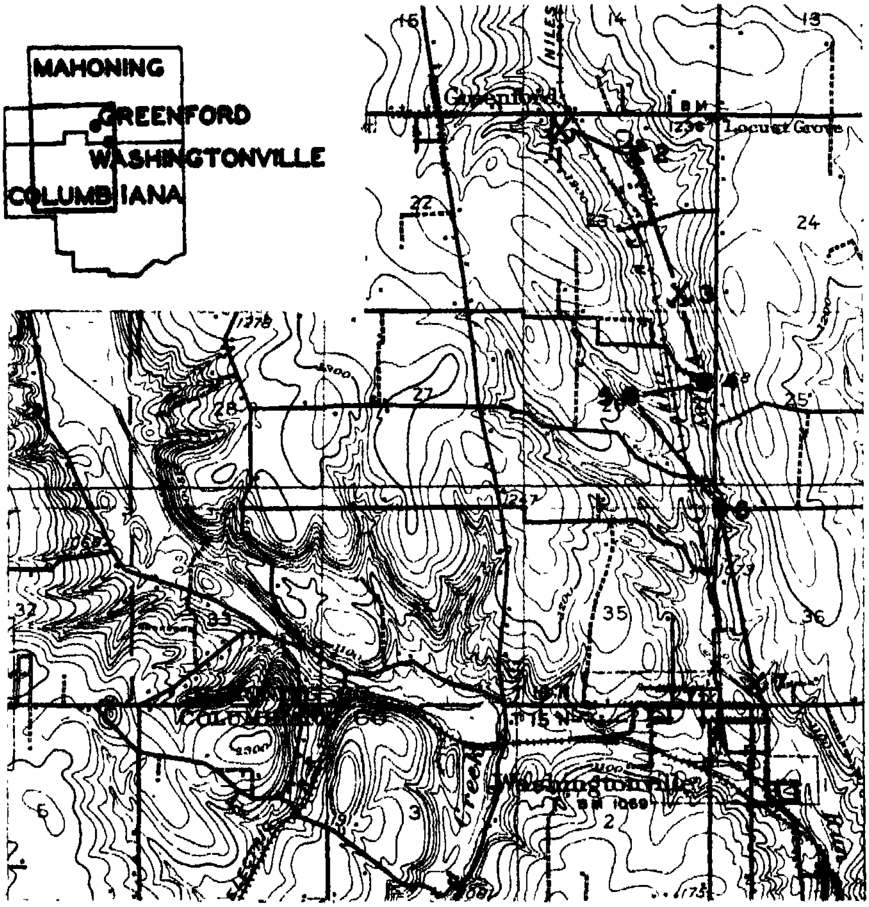
> "A mile and a half south . . at Green Station, the Lower Kittanning coal makes its first appearance. . . . It has been mined here by Andrew Reichstadt on section 23. It lies about 15 feet above the railroad. . . .

---

[1] Newberry, J. S.: *Report on the Geology of Mahoning County*, Geol. Surv. Ohio, Vol. III, p. 812. (1878.)

[2] Orton, Ed.: *The Stratigraphical Order of the Lower Coal Measures of Ohio*, Geol. Surv. Ohio, Vol. V, pp. 32-33. (1884.)

"The (Lower) Kittanning coal can be followed from Green Station to the southward along the valley of the Cherry Fork, without difficulty. It falls a little faster than the valley, so that at the Walters Mine, section 35, Green township, it lies about level with the railroad."



SCALE $\frac{1}{62\,500}$

⚒ ACTIVE MINE

⚒ ABANDONED MINE

● EXPOSURE

Fig. 1. Portion of the Lisbon Quadrangle showing the location of Greenford and Washingtonville and the localities at which the Middle Kittanning coal and associated strata were studied. Inset shows an outline map of Mahoning and Columbiana Counties, the area within the Lisbon Quadrangle, and the location of Greenford and Washingtonville.

1. A. Reichstadt Mine.
2. M. A. Less Mine.
3. C. J. Roller Prospect Pit.
4. M. and L. Schnurrenberger Exposure.
5. E. R. Kurtz Exposure.
6. M. Roller Exposure.
7. J. A. Stouffer Mine.

Although Orton called this coal the Lower Kittanning, three miles further south at Washingtonville the Lower Kittanning coal with which he correlated the Reichstadt coal has been shown by Stout and Lamborn to be the Middle Kittanning coal.[3]

No detailed section of this mine was published until 1923, when Stout wrote as follows.[4]

> "At Greenford, Green Township, the same members are worked by the Kopp Klay Kompany for the manufacture of building block. The beds are reached by a slope. A record taken in the mine follows:
>
> | | |
> |---|---|
> | Shale | |
> | Coal, *Lower Kittanning* | 2′ 3″ |
> | Clay, light, lower part siliceous, *Lower Kittanning* | 7′ 0″ |
> | Shale, siliceous. | |
>
> "The thickness of the clay varies from 6 to 8 feet, but averages about 7 feet. The overlying coal is of fair quality and is used in manufacturing the clay into ware. The clay is above drainage along the main valleys in the southern part of the county, but owing to the thick covering of drift it is seldom well exposed for measurement The quantity of material available, however, appears to be large."

Lamborn gives an almost identical section in a recent report.[5]

As can readily be seen from reading the above there have been different opinions of the correlation of the coal and clay in the Reichstadt mine. Orton and possibly Newberry believed them to be the Middle Kittanning members, and more recently Stout and Lamborn have identified them as the Lower Kittanning members The mine is now abandoned and cannot be restudied at present.

In 1939 I visited a new mine which had been opened at approximately the same level and presumably on the same coal and clay almost directly across the valley on the east side of Cherry Valley Run on the Mary A. Less farm in the northeast quarter, Section 23, Green Township, Mahoning County. The rocks in this new mine, herein called the Less mine, were studied at that time, and the section of the strata is as follows.

9.	Sandstone: gray, massive or bedded, fine grained, exposed, *Lower Freeport*		6′ 0″
8.	Shale: gray, slickensided		2′ 6″
7.	Shale: dark gray, pyritiferous, nodular, fossiliferous	*Washingtonville*	0′ 5″
6.	Shale: black, bony, sparingly fossiliferous		1′ 6″
5.	Shale: gray, slickensided; with clay ironstone concretions		4′ 6″
4.	Shale: black, bony, fossiliferous		0′ 9″
3.	Coal: bony, resembles cannel coal	*Middle Kittanning*	0′ 6″
2.	Coal: with thin irregular marcasite partings		2′ 0″
1.	Clay: light gray with a few inches of dark clay at base of the coal at most places in the mine, plastic; with lenses of light gray, fine, compact sandstone up to 1 foot in thickness, exposed		10′ 0″

From a comparison of the above section with the local lithology of the Lower and Middle Kittanning coals and their associated strata it was reasonably certain that these were the Middle Kittanning coal and clay. The strata associated with the Kittanning coals in this vicinity normally have such a different lithology and succession that each can be readily recognized at most places. The following is a complete and composite section illustrating the local stratigraphy of these two coals and associated strata:

---

[3] Stout, W., and Lamborn, R. E.: *Geology of Columbiana County*, Geol. Surv. Ohio, 4th series, Bull. 28, pp. 158–159. (1924.)

[4] Stout, W. et al.: *Coal Formation Clays of Ohio*, Geol. Surv. Ohio, 4th series, Bull 26, p. 382. (1923.)

[5] Lamborn, R. E.: *The Coal Beds in Southeastern Mahoning County*, Geol. Surv. Ohio, 4th series, Bull. 43, p. 30. (1942.)

17.	Sandstone, *Lower Freeport.*		
16.	Shale: gray; with clay ironstone concretions, thickness variable		6′ 0″
15.	Shale: black, bony, fossiliferous, marine, *Washingtonville.*		1′ 6″
14.	Shale: dark gray; with clay ironstone concretions, thickness variable		3′ 6″
13:	Coal, *Middle Kittanning*		2′ 4″
12.	Clay: gray, plastic, siliceous		1′ 6″
11.	Limestone: gray, nodular, ferruginous, freshwater, *Salem*		1′ 0″
10.	Clay: very local, *Oak Hill*		2′ 0″
9.	Shale and (or) sandstone		30′ 0″
8.	Shale: gray, fossiliferous, marine	*Hamden*	4′ 0″
7.	Shale: gray to gray-black, fossiliferous, marine; with nodular fossiliferous limestone; locally with cone-in-cone		0′ 10″
6.	Shale: black, bony, fossiliferous, brackish or marine		0′ 8″
5.	Coal, *Lower Kittanning*		3′ 0″
4.	Clay: gray, plastic		2′ 6″
3.	Coal: impure, locally absent, *Lawrence*		1′ 8″
2.	Clay: gray, plastic		8′ 0″
1.	Shale and sandstone		25±′

The following features of the section in the Lees mine suggest the Middle Kittanning members:

(1) The presence of the sandstone, zone 9.
(2) The presence of the fossiliferous shale, zones 6 and 7.
(3) The presence of shale with clay ironstone concretions, zone 5.
(4) The absence of a nodular marine limestone, zone 7 in the above composite section.
(5) The absence of an impure coal in the underclay, zone 3 in the above composite section
(6) The thickness of the coal, zones 2 and 3.

On the other hand, some of the features of the same section are indicative of the Lower Kittanning members:

(1) The presence of black, bony, fossiliferous shale immediately overlying the coal, zone 4.
(2) The presence of cannel coal on top of the bituminous coal, zone 3.
(3) The absence of the nodular freshwater limestone at the base of the Middle Kittanning underclay, zone 11 of the composite section.
(4) The thickness of the underclay, zone 1.

Unfortunately none of these evidences is positive proof of either member; for exceptions are ever the rule in the lithology and stratigraphy of the coal measures. For example, the distribution of both the Salem and Washingtonville members is irregular, and there are localities where fossils are in the layers immediately on top of the Middle Kittanning coal as occur in Section 26, Perry Township, Columbiana County and at Teegarden in Section 32, Salem Township, Columbiana County.[8] There is still another means of checking the identity of these members.

---

[8] Sturgeon, M. T.: *The Stratigraphy and Paleontology of the Middle Portion of the Allegheny Formation of the Lisbon (Ohio) Quadrangle*, Master's Thesis, Ohio State University, pp. 40 and 47. (1933.)

Both Kittanning coals are definitely known and were formerly extensively mined in the vicinity of Washingtonville, which is distant from the Less mine about three miles south and a little east along Cherry Valley Run. There the Lower Kittanning coal is below drainage but was seen in one mine which was in operation in 1939 on the east side of Cherry Valley Run in the southwest corner of Section 36, Green Township, Mahoning County. The old Middle Kittanning mines are abandoned, but in spite of slumped debris this coal can still be seen at several places. A small mine on the J. A. Stouffer property which is nearby to the above Lower Kittanning mine, was studied by Stout and Lamborn and is the type section of the Washingtonville shale. The Middle Kittanning coal is no longer exposed at the Stouffer mine, but the Washingtonville shale is still visible, and the position of the coal can easily be determined from Stout and Lamborn's published section.

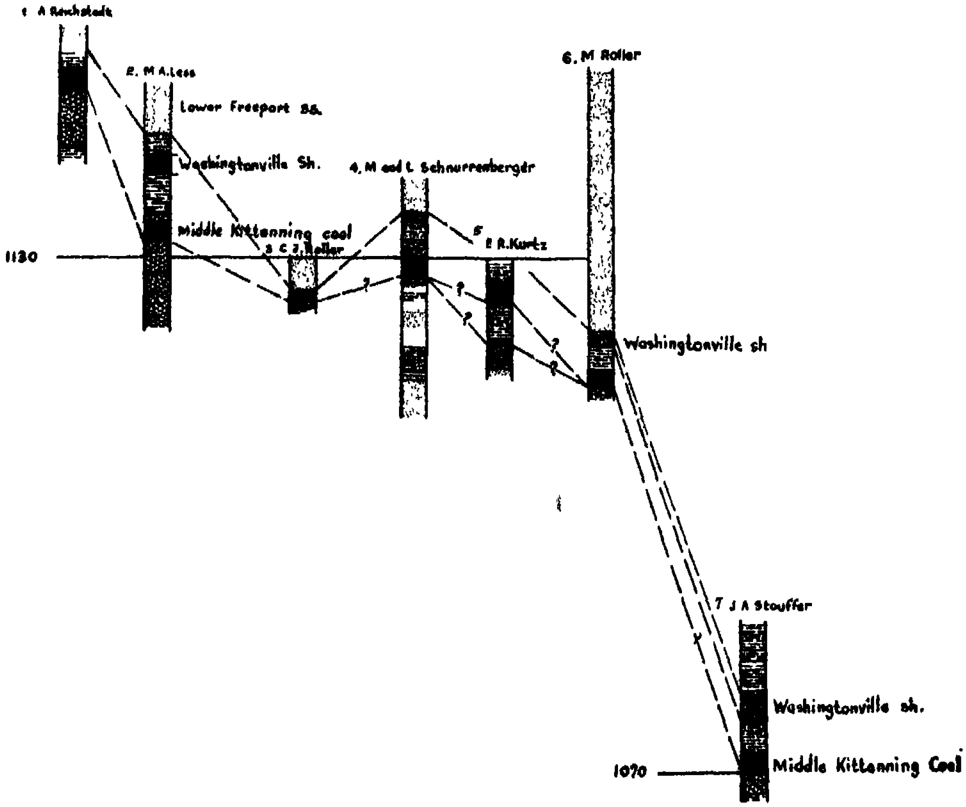


FIG. 2. Correlation diagram of the Middle Kittanning coal and associated strata between Greenford and Washingtonville, Ohio

Along the east side of Cherry Valley Run between the Less mine at Greenford and the J. A. Stouffer mine at Washingtonville are a number of locations where the Middle Kittanning coal can be seen or has been prospected or mined. The level of the coal can be traced with reasonable certainty from one location to another, although several of the mines and prospect pits are so covered with debris and vegetation that the strata cannot be seen. All the localities at which the Middle Kittanning coal is exposed on the east side of Cherry Valley Run between Greenford and Washingtonville have been studied and plotted graphically in an attempt to determine the true identity of the coal and clay in the Less mine. The descriptions of these localities, all of which are in Green Township, Mahoning County, are given below. The map shown in Figure 1 illustrates the relative position and the chart shown in Figure 2 gives the lithologic and stratigraphic relationships of the above localities.

The first of these localities is at Washingtonville in the now abandoned J. A. Stouffer mine in the southwest quarter of Section 36. This is the section described by Stout and Lamborn as the type for the Washingtonville shale, and their section is quoted below.[7]

	Feet	Inches
Shale, gray	3	0
Shale, gray, with ore nodules	4	0
Shale, with two layers of iron ore		8
Shale, gray		8
Shale, bony, carbonaceous, fossiliferous, *Washingtonville*	3	0
Shale, dark, fissile, siliceous	3	8
Coal, *Middle Kittanning*	2	4
Clay, siliceous	3	0

The next exposure is about a mile north of Washingtonville along the Washingtonville-Canfield road. Here just south of the old schoolhouse in Section 25 this north-south road was changed several years ago, and the following strata were exposed: (See Figure 3.)

6.	Sandstone: light gray, fine, micaceous, cross and irregularly bedded; with streaks of coal, plant fossils and clay ironstone concretions, base irregular, exposed, *Lower Freeport*	30′	0″
5.	Shale: dark gray; with numerous small clay ironstone nodules	0′	6″
4.	Shale: black, bony, sparingly fossiliferous, *Washingtonville*	1′	1″
3.	Shale: light gray	2′	8″
2.	Coal, *Middle Kittanning*	2′	2″
1.	Clay: light gray, plastic, exposed	1′	0″

This section, herein called the M. Roller section, is no longer well exposed, and the top of the Middle Kittanning coal which was formerly exposed on the east side of the road opposite the May Roller farm buildings cannot be seen at present. However, the coal rises rather sharply to the northward toward the old schoolhouse, and from the now covered exposure in the roadside ditch opposite the Roller buildings it rises 21 feet in a distance of 500 feet toward the schoolhouse, and at that point the Middle Kittanning coal can still be dug out on the east side of and just above the road level.

The Washingtonville shale is well exposed and typical in lithology but only sparingly fossiliferous. The other associated strata are thinner than at Washingtonville but the principal difference is the presence of the base of the Lower Freeport sandstone only a little over four feet above the top of the Middle Kittanning coal.

The next exposure is about 0.6 of a mile further north on the west side of the Washingtonville-Canfield road. Here a road formerly joined the north-south road from the west at an elevation of 1168. The exposure, herein called the Schnurrenberger section, is in a small ravine that parallels the abandoned road and leads westward to Cherry Valley Run:

---

[7] Stout, W. and Lamborn, R. E.: *Op. cit.*, pp. 159 and 177. (1924.)

FIG. 3. A. Lower Freeport sandstone and Washingtonville shale (at hammer) on east side of Washingtonville-Canfield road opposite M. Roller farm buildings

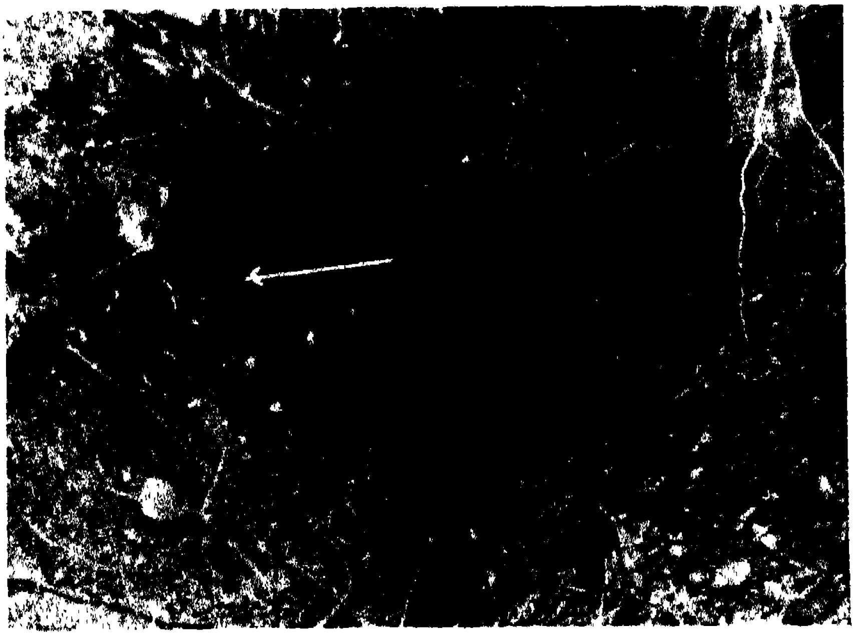


FIG. 3. B. Lower Freeport sandstone and Middle Kittanning coal (at arrow) in prospect pit on C. J. Roller farm.

8.	Sandstone: gray, thin-bedded, fine, friable, exposed, *Lower Freeport*		3′	6″
7.	Clay: gray-buff, plastic		1′	0″
6.	Shale: gray-buff, soft but arenaceous; with 5-inch layer of sandstone near base		2′	0″
5.	Clay: with dark shaly layers		2′	4″
4.	Coal: shaly	*Middle Kittanning*	0′	5″
3.	Coal: good		1′	6″
2.	Clay, shale and sandstone: this is largely a covered interval		12′	0″
1.	Sandstone: gray, medium, massive, friable; with some plant fossils, exposed		4′	0″

The elevation of the Middle Kittanning coal is 1128 here, and at the M. Roller section the same coal varies from 1115 to 1136. This section is a little unusual in the clay or clay-shale above the coal and in the absence of the Washingtonville shale. Almost due west of this on the west side of Cherry Valley Run on the E. R. Kurtz farm in the north-central part of Section 26 is the following section:[8]

8.	Shale: gray-black, weathered, exposed	2′	0″
7.	Coal, *Middle Kittanning*	2′	3″
6.	Clay: gray, plastic, carbonaceous	1′	7″
5.	Shale: gray-black, carbonaceous, siliceous	2′	9″
4.	Coal	0′	4½″
3.	Coal: shaly	0′	5″
2.	Clay: gray, plastic; with a 6-inch layer of clay ironstone concretions one foot above the base, *Salem?*	2′	8″
1.	Sandstone at creek level.		

Here the elevation is between 1120 and 1130. This exposure which is only about one-half mile southwest of the Schnurrenberger exposure suggests an alternative interpretation to that section. The coal called the Middle Kittanning coal in the Schnurrenberger section may be the lower coal, zones 3 and 4, on the Kurtz farm. If this interpretation is the true one, then it is probable that the Lower Freeport sandstone displaces both the Washingtonville shale and the Middle Kittanning coal at the 1168 road intersection and the plastic clay overlying the coal in that section is really the Middle Kittanning underclay. Also if that is the case, then the coal in the Schnurrenberger section and the lower coal in the Kurtz section probably are the local coal (Strasburg) above the Oak Hill clay. The Oak Hill member belongs in the interval between the Salem and Hamden members and is absent at most places in this vicinity.

In the wood lot on the east side of Cherry Valley Run on the C. J. Roller farm in the southeast quarter of Section 23, the Middle Kittanning coal has been prospected and the section of the exposed strata is as follows: (See Figure 3.)

3.	Sandstone: gray-buff, bedded, micaceous, exposed, *Lower Freeport*	4′	0″
2.	Coal, *Middle Kittanning*	1′	6″
1.	Clay: gray-buff, plastic, exposed	1′	0″

The approximate elevation of the Middle Kittanning coal here is 1125. The base of the Lower Freeport sandstone rests directly upon the Middle Kittanning coal, and this relationship probably accounts for the thinness of the latter member. Along this slope the position of the base of the Lower Freeport sandstone and presumably the position of the Middle Kittanning coal is marked by several springs, and a half mile further north at the C. J. Roller buildings there is an abandoned mine. The coal is no longer visible, but several feet of thickness of the Lower Freeport member can be seen. The elevation of the coal here is approximately 1120. It is less than half a mile from the C. J. Roller buildings to the Less mine from which the clay is taken at present for the Kopp Tile plant and which was described previously in this report. The elevation of the Middle Kittanning coal in the Less mine is probably between 1130 and 1135. In the two ravines between the C. J. Roller farm buildings and the Less mine the Lower Freeport sandstone is well exposed with an exposed thickness of about 75 feet.

---

[8] Sturgeon, M. T.: *Op. cit.*, pp. 38–39.

From the available evidence in the field the uncertain coal and clay in the Less mine can be traced along the east side of Cherry Valley Run without reasonable doubt into the certain Middle Kittanning members at Washingtonville. This is evident not only from similar elevations but also from similar lithology as is shown in Figure 2. There is a sharp drop in the elevation of the coal between the M. Roller and J. A. Stouffer localities, and this might cause some concern over the correlation were it not for the fact that a sharp descent in the Middle Kittanning coal is present at the M. Roller exposure. The Lower Freeport sandstone is a steady member from the Less mine south as far as the road cut opposite the M. Roller section. It varies in position from a few feet above the Middle Kittanning coal to resting directly upon or even cutting out and replacing that coal. The base of this sandstone is a disconformable one. This relationship of the Lower Freeport sandstone accounts for the absence of the marine Washingtonville shale at several of the described localities. Fortunately the Washingtonville member is present not only in its type section at the J. A. Stouffer mine but also along the road opposite the M. Roller buildings and in the Less mine itself.

That brings us back to the original problem—the identity of the coal and clay in the old Reichstadt mine at the Kopp Klay plant. To the evidence already presented concerning this mine from the written reports of Orton, Stout, and Lamborn, a few additional facts can be added. Mr. Ira Wisler, who was a miner for a number of years in the Reichstadt mine, has recently informed me that at a close but variable distance above the top of the coal was the base of a heavy sandstone which is undoubtedly the Lower Freeport. He further reported a few inches of black "slate" on top of the coal, and concerning this "slate" Orton wrote as follows:[9]

> "There are 2½ feet of bituminous coal, overlain with 4 to 6 inches of cannel "

The same is present in the Less mine where it is six inches thick. The underclay which had a thickness of ten or more feet was without any trace of a second layer or even streaks of coal but did contain at least locally some nodules of presumably clay ironstone or limestone larger than the size of one's first. The ware made from this clay forms little blisters from iron impurities at 2100° F., but ware made from Lower Kittanning clay from nearby North Lima is without similar blisters when burned at a temperature of 2700° F.

While I have no accurate drill records at or near this mine, the general report is that there is another coal about 40 feet below the coal worked in the Reichstadt mine, which, if true, would be the Lower Kittanning coal.

This great thickness of the clay in both the Reichstadt and Less mines is typical of the Lower Kittanning clay combined with the Lawrence clay, rather than of the Middle Kittanning clay in this vicinity. Orton reported, however, that two and a half miles further south in the old Walters mine the Middle Kittanning clay was seven feet thick.[10]

---

[9] Orton, Ed.: *Op. cit.*, p. 33.

[10] Idem., p. 33.

The elevation of the coal in the Reichstadt mine has not been accurately determined, but Orton wrote that it was 15 feet above the Erie Railroad, which would make it a few feet higher than it is in the Less mine across the valley.

All the available evidence concerning the Reichstadt and Less mines convinces me that the Middle Kittanning coal and clay are present in both and that Orton was correct when he correlated the coal in the Reichstadt mine with the Middle Kittanning coal in the vicinity of Washingtonville.

BIBLIOGRAPHY

1. **Lamborn, R. E.** *The Coal Beds in Southeastern Mahoning County*, Geol. Surv. Ohio, 4th series, Bull. 43, 1942.
2. **Newberry, J. S.** *Report on the Geology of Mahoning County*, Geol. Surv. Ohio, Vol. III, 1878.
3. **Orton, Ed.** *The Stratigraphical Order of the Lower Coal Measures of Ohio*, Geol. Surv. Ohio, Vol. V, 1884.
4. **Stout, W., et al.** *Coal Formation Clays of Ohio*, Geol. Surv. Ohio, 4th series, Bull. 26, 1923.
5. **Stout, W., and Lamborn, R. E.** *Geology of Columbiana County*, Geol. Surv. of Ohio, 4th series, Bull. 28, 1924.
6. **Sturgeon, M. T.** *The Stratigraphy and Paleontology of the Middle Portion of the Allegheny Formation of the Lisbon (Ohio) Quadrangle*, Master's Thesis, Ohio State University, 1933.

Bird Behavior

Volume I of this series ("A Population Study of the Song Sparrow," Trans. Linn. Soc. N. Y., Vol. 4, 1937) dealt with the vital statistics of a group of song sparrows in Columbus, Ohio; the present volume deals with the behavior of passerine birds, with the song sparrow as the chief example, and takes the bird from hatching to maturity and through its own parental activities. These two volumes are the result of a thorough and painstaking study over an 8-year period of a song sparrow population in Columbus, Ohio, together with numerous observations in Massachusetts and Oklahoma, and observations on some two dozen hand-reared birds in Austria and in this country. This is probably the most thorough study ever made of a single species of bird.

Following a brief outline of the general principles of animal psychology as they relate to birds (Ch. I), the author in succeeding chapters discusses the various activities of the bird throughout its life: the development and behavior of the young bird (II-VI), the general nature of the song sparrow society (VII), awakening and roosting (VIII), the nature, development, inheritance, and function of song (IX-XI), territory in the song sparrow and other birds (XII-XIII), mating and inter-individual relationships (XIV-XVI), the nest, eggs, and care and defense of the young (XVII-XX), enemy recognition (XXI), innate and learned behavior in the adult bird, and analogies with the behavior of other vertebrates (XXII). At the end of each chapter is a brief summary of the subject matter in the chapter. The appendices (I-V) contain detailed accounts of vocalization, dominance, and pair formation in song sparrows, and a list of species in which injury-feigning has been reported. At the end of the book is a 29-page bibliography and a complete index.

This volume presents a very thorough analysis of bird behavior. A tremendous amount of work, both in the field and with the literature, has gone into the preparation of this volume Few people have the patience, or the command of the literature (particularly the European literature), to carry on a study of this sort. A vast amount of the author's detailed observations is included, but the material is well organized and clearly presented. A number of questions are raised which should stimulate further study.

This book is essentially a monograph on bird behavior, with particular reference to the song sparrow. We recommend it heartily not only to all ornithologists, but to anyone interested in animal behavior. It is a compendium of information on the subject.—*D. J. Borror.*

Studies in the Life History of the Song Sparrow. II. The Behavior of the Song Sparrow and other Passerines. By Margaret Morse Nice. Trans. Linn. Soc. New York, VI, September, 1943. Pp. viii+329, 1 plate, 6 figures, 26 tables; paper bound, 6 x 9 inches. Price, $2.75.

A Picture-Cyclopedia of Flowers

To recognize familiar flowers quickly this small book has its uses. Prepared in the manner of commercial catalogs and by the Horace MacFarland Company, it forms a valuable small work handy for quick reference. There are 350 colored illustrations. A chapter on pests prepared by T. L. Guyton will be read with interest by his Ohio State friends.—*A. E. Waller.*

Garden Flowers in Color, by Daniel J. Foley. Macmillan Company, New York, 1943. $1.98.

ANALYSES AND CORRELATION OF FOUR NEW HAMPSHIRE BOGS

ROBERT W. KRAUSS AND GEORGE N. KENT,[1]
Oberlin College, Oberlin, Ohio

The understanding of recent paleoecology by means of the pollen analyses of strata in post-glacial bogs has developed to the point where most ecologists, and even many laymen, are familiar with the usual methods involved. Although large numbers of bogs have been analyzed and discussed with regard to the immediate locality to which they belong, there is still considerable dispute concerning the paleoecology inferred from correlations of these analyses. It is only fair to admit that much of the confusion is due to many missing links in our chain of evidence. The fact of missing links, however, is characteristic of all history, whether natural or human. This paper therefore presents another link in the chain and attempts to point out not only the implications immediately involved in the analysis of four New England bogs, but the inferences drawn from a correlation of a number of other bogs along the Atlantic Coast.

The bogs analyzed by the writer are located in the southeastern part of New Hampshire within the drainage basin of the Merrimac River. The first, Perkins bog, is one-half mile southeast of Center Barnstead in the valley of the Big River. This bog covers several acres of kettle holes and is the most northerly of those considered. Ponemah Bog lies one mile southeast of Ponemah and three miles east-southeast of Milford and consists of about 100 acres in a depression of the Souhegan outwash plain. Spruce Bog is one to two miles north-northeast of Fremont Station and consists of about 200 acres. Welsh Bog, one mile east of Raymond near the Lamprey River, rests in a kettle hole of about seven acres. The bogs are grouped closely enough to indicate a close concurrence of the analyses. The entire area was covered by the Wisconsin Ice Sheet which extended south as far as New Jersey. The bogs do differ, however, in that those of Fremont and Raymond were under salt water during the brief marine submergence of the lower Merrimac Basin as shown by Antevs (1922). Therefore since the date of retreat of the ice (probably from ten to fifteen thousand years ago) and since the retreat of the sea from the area occupied by the two bogs above mentioned, the region has been open to the stages of succession governed by climate to the present time. Apparently the record in each bog is complete from the beginning of peat formation to the present, as the upper levels have remained intact.

The methods of boring and pollen extraction are, as a whole, familiar. The borings were taken at one-foot intervals with a Davis Borer. The deepest boring was taken at the end of actual peat on the bottom of the bogs. It would have been more desirable if some penetration into the sand and clay bottoms below the peat could have been made. Significant additions to the profiles were secured in this manner by Deevey (1939). The samples of peat (about ten c.c.) were placed in 50 c.c. vials of alcoholic potash and sent to the Oberlin Botanical Laboratory. From each vial, from .5 to 1 c.c. of material was removed—by tweezers or by pipette if well digested—and placed in a centrifuge tube to be boiled for a short time with 10 per cent KOH to complete the digestion of the peat.

---

[1] Material was collected by the junior author, now with the armed forces. The analyses and all correlation were done by the senior author who also prepared the manuscript. He wishes to express his thanks to Dr. Paul B. Sears for liberal instruction and for the use of his splendid library. Dr. George T. Jones, of Oberlin, has read the manuscript and offered many helpful suggestions.

The digesting action of the alcoholic potash alone was not sufficient for best results in spite of the fact that it had been present for some time.

It may be remarked that many methods were applied to the peat in an effort to make a selection of the most satisfactory system. The new Erdtman Technique (1933) and that of Barghoorn and Bailey (1940) were applied with a number of supplementary modifications. The time required by these new techniques, however, did not seem warranted by results with this material. It is not to be assumed from this that the writer considers the above-mentioned methods generally useless. Undoubtedly under other circumstances they are of value.

After boiling and staining with one drop of safranin per tube, the mixture was centrifuged and the pollen removed from the layer at the top of the peat. Enough of the coarser material from the bottom was added to the pollen layer to allow both for the inclusion of heavier pollen and the stabilization of the film when placed on the slides to dry. Drying completed, the slides were mounted with glycerine jelly. The resulting mounts were excellent in both the number and condition of the pollen grains present. These slides were then counted for 100 grains per level. In certain cases duplicate slides were made in order to check the counts.

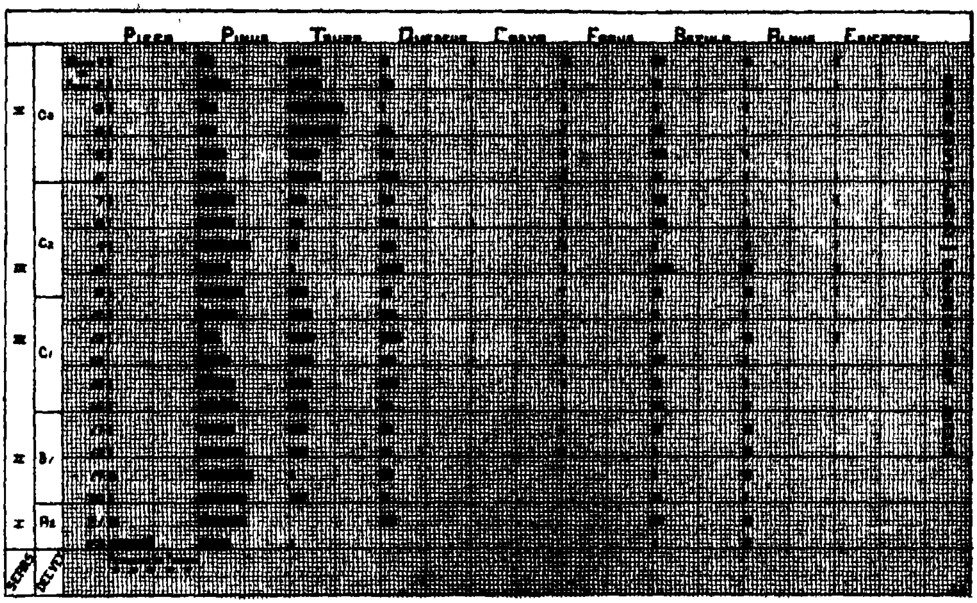


FIG. 1. Analysis of Perkins (Barnstead) Bog.

As an aid to the discussion of results, the writer will use one bog as a key to which the others will afterward be referred. The bog at Barnstead being the deepest, it is the most logical starting point for this correlation (fig. 1). Beginning the examination with the bottom layer, Spruce is obvious as the dominant. This dominance is characteristic of a cold climate. It is true, of course, that Spruce can be expected in bogs in fairly warm regions, but further investigation of Spruce decline shows that Spruce disappeared from the region except in the bog itself. Deevey (1939) considers a like Spruce maximum in Connecticut the result of the deterioration of climate which had warmed but cooled at this point, due, perhaps, to some readvance of the ice sheet. At all odds, it seems that this period of Spruce dominance can best be placed near the second phase of Deevey's earliest period, lettered A_1. It is the same period which Sears (1942) finds in his discussion of profiles in the Central States and is lettered I. This of course is the cold period which we know must have been represented by the same species of trees as those found in the Northern Coniferous Association today. How long after the retreat of ice it was before arborescent forms began to appear is not yet certain and the writer will therefore make no attempt to date this period. For those interested, however, the dates as set by De Geer (1910) for the early cold period are from 10,000 to about 8,000 years ago. It is apparently near the end of this cold period that the Barnstead Bog began its formation. Whether this Spruce maximum is the first forest community, or if, as indicated by the work of Deevey, it is the second stage of the first community, I am at this point unable to say.

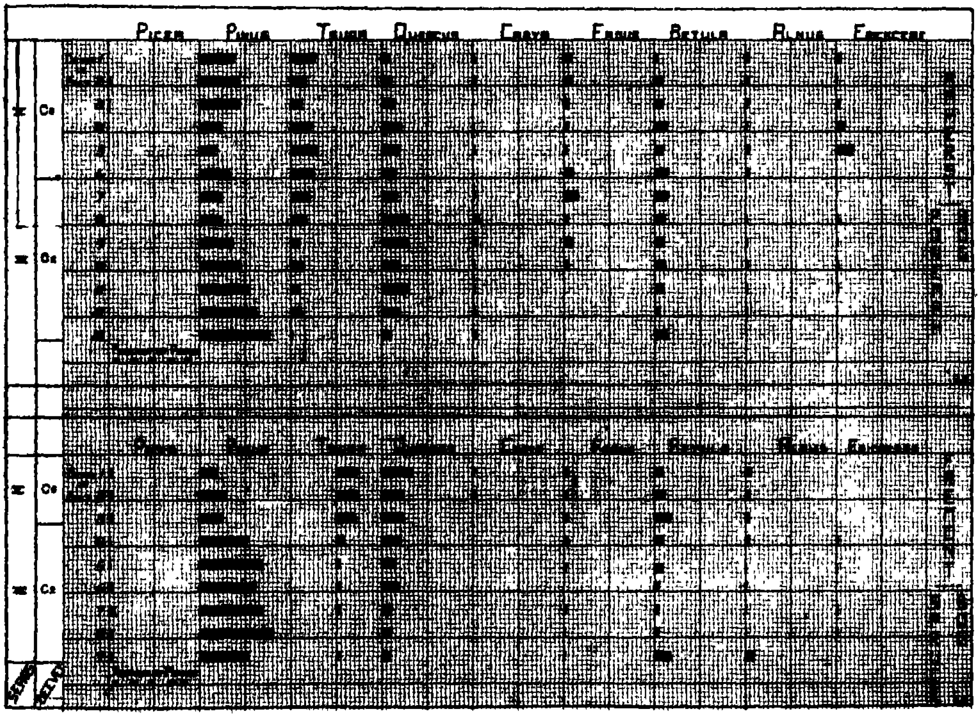


FIG. 2. Analyses of Ponemah (Amherst) Bog (above) and Spruce (Fremont) Bog (below).

Moving on up the profile, there is a quick end of the Spruce dominance. It is replaced mainly by Pine which correlates beautifully with the period marked II by Sears (1942) and B_1 by Deevey (1939). This period shows erratic increase of Hemlock and an increase in Oak. Though the species of Pine and Oak cannot be differentiated, there is considerable indication that this period may have been both cold and dry.

In the next period, letter III or C_1, the Hemlock attains significance and its first maximum appears. Immediately thereafter a deep drop in Hemlock occurs, succeeded again by a maximum near the top. The period of Hemlock minimum (apparently a dry or dry warm one) is paralleled by an Oak maximum (dry) and a Pine maximum (probably Jack Pine) as well. It is extremely unfortunate that we are unable to differentiate between species of Pine. We can only surmize that in view of the spectra the Pine is a xeric species. To show that this species is a xeric one would clinch the supposition that the cool moist period (No. III) was followed by a dry warm one. With this generalization, the spectra seem to be consistent. Beech, with the exception of an increase at level 10, also shows a decline during the warm dry period.

The increase in Beech at the top layer accompanied by a decline in Pine and Hemlock and an increase in Oak and Birch indicates a balanced Beech-Hemlock forest with large numbers of Pine, Oak, and Birch in preclimax stands. This agrees well with the present forest associations.

With periods of the Barnstead Bog pointed out, the other profiles may be examined for correlations. Taking first the bog at Amherst, it is found to be of later inception than the one at Barnstead. The lower levels showing the Spruce dominance are not found here. On the other hand, the Hemlock minimum is found at the bottom, identifying the beginning of peat formation to be in the period marked IV in the Barnstead profile. The same correlation with Pine and Oak may be made here. Beech alone seems a bit out of line which may be in part due to the average low incidence of Beech pollen—a point of difficulty in all genera of lesser representation.

The remaining two bogs are much shallower than the rest. It is to be remembered that these were under salt water during the submergence of the lower Merrimac Basin Recovery from this submergence could not have been accomplished soon. Therefore the latter two, Fremont and Raymond, correspond to the upper portions of the former two.

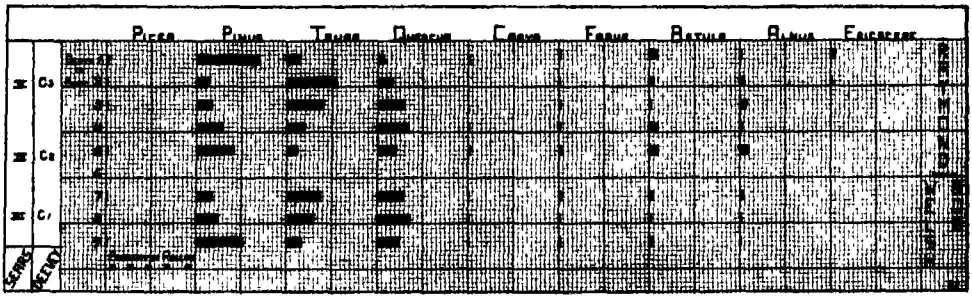


Fig. 3. Analysis of Welsh (Raymond) Bog.

The Hemlock minimum in the Fremont bog is again as is to be expected; and the Beech increase is steadier than elsewhere. The Oak increase at the top, however, is worthy of remark. Possibly the Oak found here is of the mesic Red Oak group, common successionally in the typical Beech-Hemlock forest. Again may we stress the point that a differentiation of the species of Oak is at present impossible and that it would be necessary to clinch our arguments. We have much data for fairly accurate substantiation of our own hypothesis if only these species differentiations were clear. This circumstance limits us to broader generalizations, for no matter how many analyses are made, precision will be impossible unless we can know the species of Oak and Pine in particular. The protests of Potzger (1942) and others against making any generalizations as to climate seem to us, however, scarcely warranted in view of the evident broad correlations between our results and those of Potzger (1943) and Deevey (1939).

Going on to the Raymond Bog two difficulties are met—although as a whole the bog agrees with the other three. The first problem is the recent increase of Pine not shown in the others. This may be due to the interference of man by lumbering or fire. At all odds, it is naturally unexpected and may be open to speculation. The other is that in this shallow profile we have two Hemlock minima. This would indicate a slow filling over a longer period than that of the Amherst Bog. This, though possible, is difficult to explain. The very small size of the bog may have much to do with a slow rate of filling or the local vegetation may have disturbed the profile. The erratic formation of kettle holes and resulting deposition of peat is mentioned by Deevey (1939) and is a problem in any correlation.

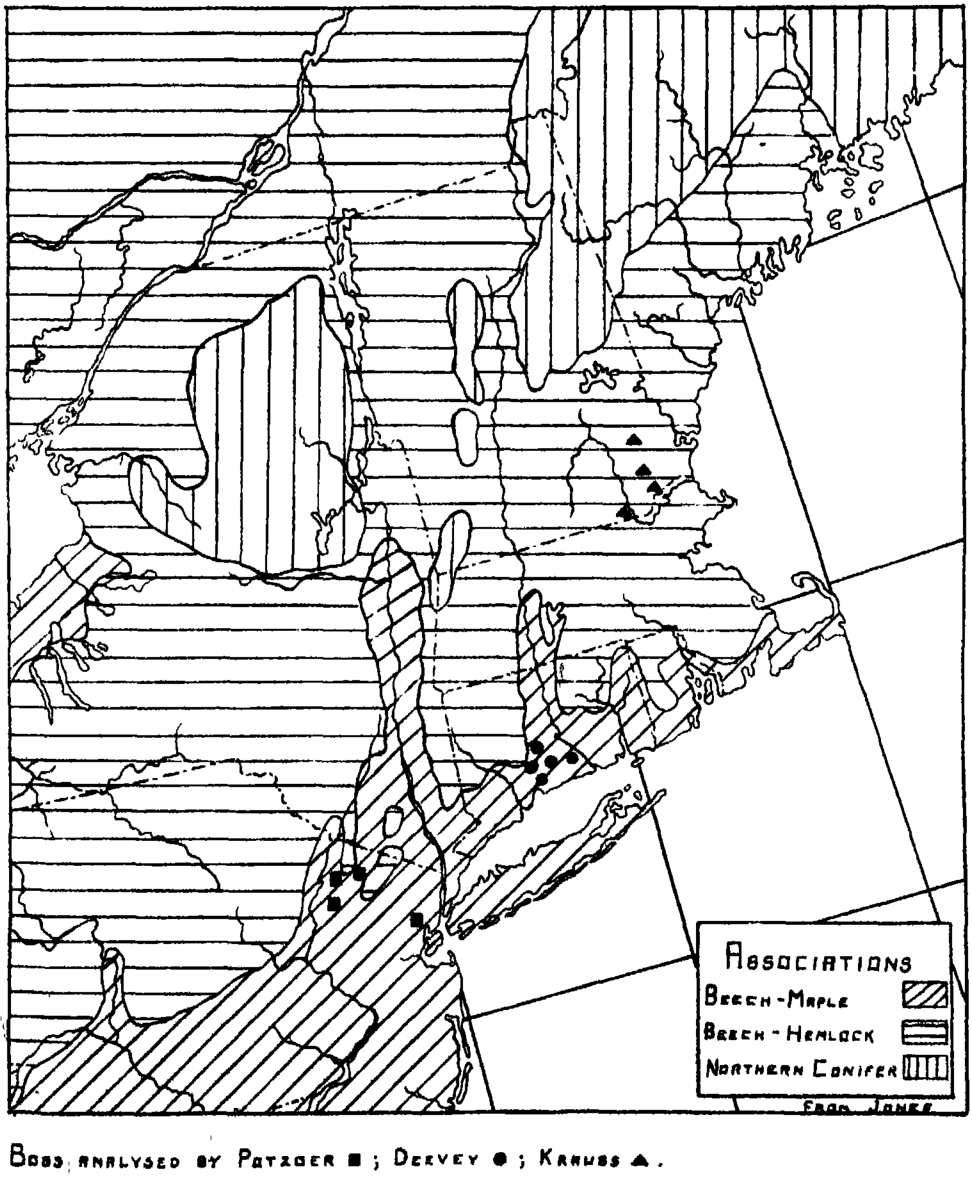


Fig. 4. Location of Coastal Bogs referred to in text.

What inferences may now be drawn from these results? First, it is obvious that these profiles indicate clearly the presence of a cool dry period after the close of the Spruce maximum. After this dry period, the Hemlock swings up to a maximum and a mesic forest community is indicated by the presence of the typical trees of the present Beech-Hemlock association. A dry and warm period follows, as shown by the marked decrease in Hemlock in agreement in all bogs. Oak and Pine species which we assume to be xerophytic occupy a dominant place in this period after which the Hemlock increases as Pine and Oak decrease and Beech increases to make up the present Beech-Hemlock-Pine forest. In the top layers there is evidence of the work of man as well.

In searching for meteorological corroboration for these shifts of climate, the writer was for a time disturbed by the fact that in order to have the xerotherm pointed out by Sears, Deevey, *et al.* (at Hemlock minimum), the cyclonic-anticyclonic fronts which now occur in the middle New England region would, of necessity, be found further north. This being true, there seemed every reason to suspect that the recession of the cold dry polar air, which had kept out the warm moist air from the Atlantic, would allow this warm moist layer to sweep over the area producing not a warm dry period but a warm moist one. This would have brought about a displacement of the coniferous forest by a Beech-Maple forest, apparent in a bog profile by a great increase in Beech. Such an effect is not shown in any of our profiles nor in those of other workers in the region.

With the possibility of this oceanic influence ruled out, it is clear that a great air movement from the West must have carried dry hot winds far enough east to alter the expected climate of the Northeastern seaboard. Meteorologically this is sound, for any movement of the fronts northward would carry the air from the Mississippi Valley in a swing east which would not be halted by either the low New England Mountain Ranges or the easterly oceanic winds. Therefore a warming at this time would allow the New England States to be influenced by mid-continent climate more than at present. The fact that these easterly bogs were affected by a dry warm period shows definitely that this period, long suspected in the mid-continent, must have been truly a far-reaching one. It is substantiated by the presence of the prairies much farther to the east than at present and by the analyses of Auer (1930), Deevey (1939), and Potzger and Otto (1943). (The latter, however, ignore the Hemlock minimum in their own paper.) The fact of apparent movement of the forests north and then again south should be of great interest to those tracing movements of the polar ice.

There is one other point raised by this analysis, when correlated with the others in the region. In New Jersey, Connecticut, New Hampshire, New Brunswick, and Nova Scotia there is a uniform decline in the abundance of Hemlock at about the same relative levels. In this period of decline there is a variation in the species of trees which take the dominance from Hemlock. In New Jersey, in the dry period, Hemlock is replaced by Oak to a great extent. In Connecticut, the Oak is as active in replacing Hemlock as in New Jersey. We do find a tendency for Pine to press into the gap. We may safely say, however, that Oak is the main representative of the dry period in these two states. In New Hampshire the Pine is the important dominant at the Hemlock minimum. Still farther north in Nova Scotia and New Brunswick (see Auer, 1930) Oak is barely present and certainly Pine is the unequivocal dominant in the dry period.

What then does this dominance of Pine in the north instead of Oak, as in the south, suggest? A clue may be noted in that there is a tension zone of climate in the New England states. Here the cyclonic fronts caused by the conflict of cold polar air with the warm southern air rule the weather. As could be expected, it is through this area that the general line separating the Beech-Maple association from the Beech-Hemlock is found. (Clements and Weaver, 1938; Jones, 1940.)

In figure 4, the bogs in New Jersey and Connecticut are seen to be in what today is Beech-Maple. Those in New Hampshire, Nova Scotia, and New Brunswick, on the other hand, are in the Beech-Hemlock Association. It appears, then, that the warm dry period produced not a northward movement of the Beech-Maple association nor any real shift of boundary at all but rather that the xeric types found in this period represent the xeric series *in their own respective associations.*

It is notable that there is such a pronounced difference in the xerotherm forests of New Hampshire and that of the same period in Connecticut only one hundred miles to the south. It is as though the climax association of today were reduced to the xeroseres peculiar to each. Is not this just what we would expect when we realize that a climax condition had been reached and well established before the beginning of the xerotherm? Nevertheless it is surprising that the line today should correspond so closely to what it was perhaps three or four thousand years ago. It indicates a stability of forest associations and their seres not previously pointed out and certainly calls for further ecological investigations.

LITERATURE CITED

1. **Antevs, E.** The Recession of the last ice sheet in New England. Amer. Geog. Soc. New York. 1922.
2. **Auer, V.** Peat bogs in southeastern Canada. Can. Geol. Surv. Mem. 162: 1–32. 1930.
3. **Barghoorn, E. S., and I. W. Bailey.** A useful method for the study of pollen in peat. Ecology, 21 (4): 513–514. 1940.
4. **Deevey, E. S.** Studies on Connecticut lake sediments. Amer. Jour. Sci., 237: 691–724. 1939.
5. **DeGeer, Gerard.** A geochronology of the last 12,000 years. Congr. Geol. Int., 11. Compte rendu 1. 1910.
6. **Erdtman, G., and Erdtman, H.** The improvement of pollen analysis technique. Svensk. Bot. Tid., 27 (3): 347–357. 1933.
7. **Jones, G. T.** Notes on Plant Ecology (mimeographed). Oberlin, 1940.
8. **Potzger, J. E., and J. H. Otto.** Post-glacial forest succession in northern New Jersey as shown by pollen records from five bogs. Amer. Jour. Bot., 30 (2): 83–87. 1943.
9. **Sears, P. B.** Forest sequences in the North Central States. Bot. Gaz., 103 (4): 751-761. 1942.
10. **Weaver, J. E., and F. E. Clements.** Plant Ecology. McGraw-Hill. 1938.

Cytology

This new book by Professor Sharp is intended as an elementary text to be used in courses following beginning botany and zoology. The plan is similar to that of his well-known "Introduction to Cytology," but with the material receiving a simpler treatment in an attempt to meet the level of understanding of students with only an elementary background. The first chapter traces cytological developments and outlines the position of cytology in biological science. The following chapter is a discussion of the organism as a whole and the cell. The next four chapters present the structural components of protoplasts, the physical characteristics of protoplasm, division of the protoplast and the cell wall structures. The structure of chromosomes is discussed and nicely illustrated in Chapter 7. This discussion includes the giant chromosomes of *Drosophila*, *Sciara* and *Chironomus*. The subject of Chapter 8 is Meiosis. The chapter is carefully written and illustrated, including material from both plants and animals. The succeeding three chapters deal with the cytology and reproduction in plants and animals. These are followed by chapters on cytology and Mendelian heredity, chromosomal aberrations, chromosome numbers and their alteration and cytological aspect of hybridity. This includes recent work on the induction of tetraploids by use of colchicine, resulting in new fertile types from sterile but desirable hybrids. A brief summation of our knowledge of the role of cytoplasm in development and heredity appears in Chapter 17. The last chapter adds a new phase and application of cytology to the important biological problem of taxonomy. No specific references are given in any of the chapters. However, at the end, ten pages of "Suggested Reading" are included. This new work of Professor Sharp will likely meet the need of many as a text for undergraduates.—*G. W. B.*

Fundamentals of Cytology, by Lester W. Sharp; 267 pages, 6 x 9, 176 illustrations. McGraw-Hill Book Company, New York. $3.00.

THE GENETICS OF CERTAIN COMMON VARIATIONS IN COLEUS[1]

DAVID C. RIFE,
The Ohio State University,[2]
Columbus, Ohio

Coleus are characterized by great variations in leaf color, and to a lesser degree by variations in leaf form and flower type. Genetic breeding experiments now being conducted at the Ohio State University have to date revealed at least eight sets of alleles responsible for many common variations.

Boye and Rife (1937) reported the difference between solid purple leaf color and green leaves with a brown pattern on the upper epidermis (see Fig. 1) to be due to a single pair of alleles, purple being dominant to pattern. Likewise, in the Golden Bedder strain, solid green appeared to be dominant to pattern. Another set of alleles was shown to determine whether the plant has an intense or dilute green pigmentation, the intense green being dominant to the dilute green. Later work by Boye (1941) showed that the genes responsible for solid purple, solid green and pattern belong to a single allelic series. The gene responsible for solid purple, (P) and the one responsible for solid green (p^G) are each dominant to the one resulting in pattern (p). The genes P and p^G show no dominance to each other, plants of genotype Pp^G being of a bronze gray color. The genes responsible for intense and dilute green (I, i) do not appear to be linked with the P series (see Table 6b).

Crinkly leaves have been shown to be due to a single dominant factor (C) and smooth leaves to its recessive allele (Rife, 1940). The P and C series are not linked. Deep lobed leaves were shown to be due to a simple dominant factor, and in the strain investigated by Rife (1940), were always associated with male sterile flowers.

PATTERN, MOTTLING AND SOLID COLOR

Coleus plants frequently exhibit various degrees of speckling or mottling of anthocyanin on the upper leaf surface; as contrasted with either a characteristic pattern or complete absence of anthosyanin (Fig. 1). There is great variation in the type of mottling, which would seem to indicate that multiple factors are concerned in its expression. Table 1 shows the results of selfing several mottled plants. In each instance patterned, mottled and solid colored progeny were produced. Patterned plants from such progenies always breed true, and solid colored plants usually do so. This would seem to indicate that mottling is due to the heterozygous state of the factors determining pattern versus solid color. An examination of Table 1 shows that the ratios deviate significantly from a 1 : 2 : 1, there being too few mottled and too many solid colored plants. If we test progenies for 3 : 1 ratios (three solid and mottled, one patterned), however, there is no significant deviation from the expected. Slight mottling frequently will not appear until the plants have become fairly large. Space limitations usually render it impossible to maintain complete progenies until they have reached such size, and it seems likely that when the counts were made, many potentially mottled plants were classed as solid colored. We shall henceforth use the symbols TT to designate the genotype of solid color, tt the genotype of patterned plants, and Tt that of mottled plants. The degree of mottling is apparently determined by multiple modifiers.

---

[1] Genetic Studies of Coleus No. IV.

[2] Department of Zoology and Entomology, Genetics Laboratory.

When plants of genotypes tt and Tt are crossed with plants of genotype p^Gp^G all of the progeny are solid green. When plants of genotype TT are crossed with plants of genotype PP, the progeny are purple, rather than bronze gray. These observations indicate that the p factor of the purple series does not result in the

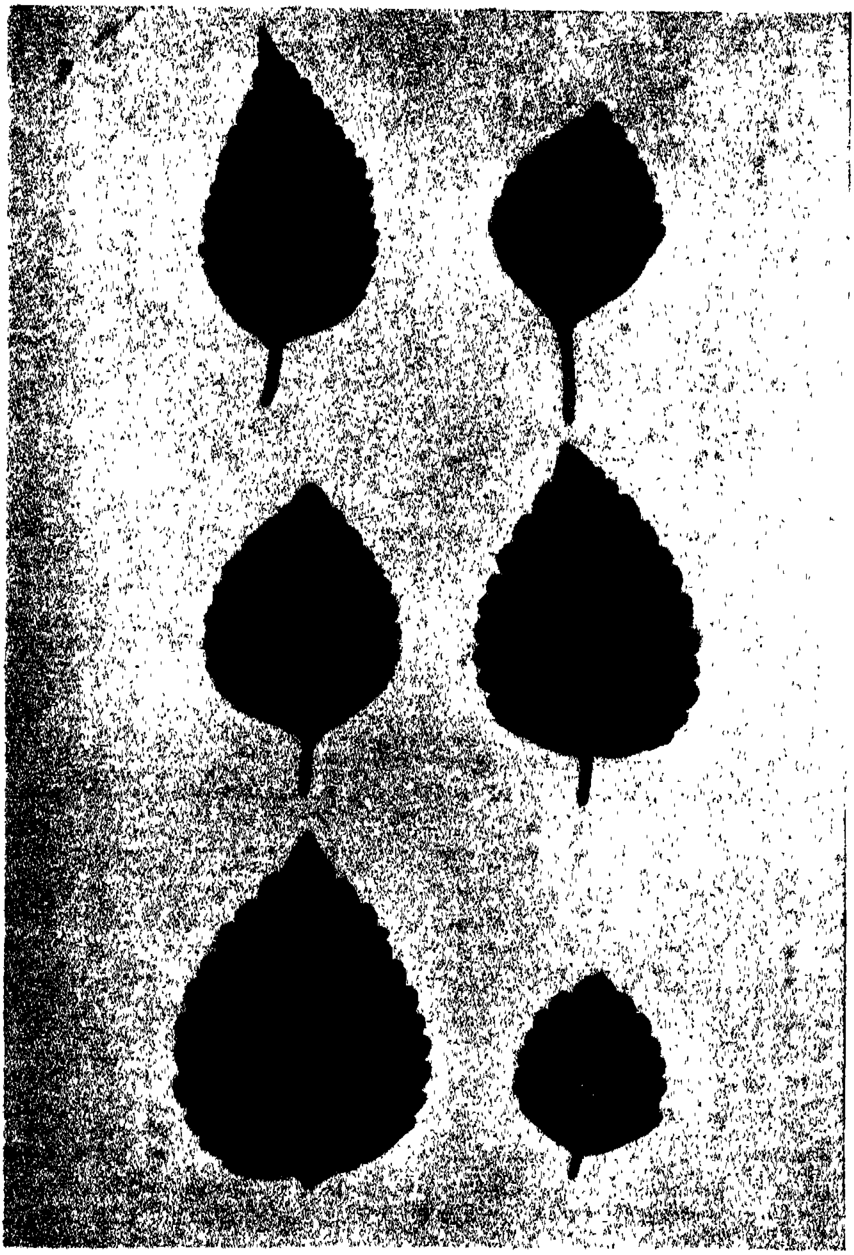


FIG. 1. Color variations in coleus leaves. Upper row, solid green on left, pattern on right. Middle row, speckling and mottling. Lower row, distinct pattern and chlorophyll deficient on left, faint pattern and chlorophyll deficient on right.

formation of a pattern, but rather is responsible for a solid green, phenotypically the same as that produced by p^G. The two types of solid green differ in breeding behavior in that p^G is epistatic to t, whereas T is epistatic to p. Apparently the plants used by Boye (1941) in the analysis of the P series were homozygous for tt, thus making it possible to differentiate between the two types of green on the basis of the presence or absence of patterns.

TABLE 1

Analysis of Data Obtained by Selfing Mottled and Speckled Plants

A.

Seed Sample	*Pattern*	*Mottled*	*Solid*	X^2	*df*	*Probability*
1	25	33	42	17.340	2	very small
2	17	20	17	3.628	2	0.3 -0.05
3	6	16	12	3.353	2	0.3 -0.05
4	20	36	23	0.638	2	0.95-0.7
5	5	8	9	3.231	2	0.3 -0 05
	73	113	103	28.190	10	very small

Deviation
df=2
X^2=20.274
p=very small

Heterogeneity
df=8
X^2=7.984
p=0 5-0.3

B.

Seed Sample	*Pattern*	*Mottled and Solid*	X^2	*df*	*Probability*
1	25	75	0 0001	1	0.99
2	17	37	1.390	1	0.3 -0.05
3	6	28	0 789	1	0.5- 0.3
4	20	59	0.001	1	0.99
5	5	17	0 001	1	0.99
	73	216	2 181	5	0.95-0 7

Deviation
df=1
X^2=0 009
p=0 99

Heterogeneity
df=4
X^2=2 172
p=0.97-0.70

LEAF LOBES AND MALE STERILITY

In addition to the strain of plants in which deep lobes are associated with male sterility reported by Rife (1940), deep lobes have subsequently been discovered in two other strains. In one of these the male flowers are completely fertile, and the degree of lobing is indistinguishable from that in the strain characterized by male sterility. In the other strain there is variability in the degree of lobing in the heterzygous plants, which usually show lobes not so deep as do plants homozygous for deep lobing. Homozygous deep lobed plants are almost completely male sterile, although a few seeds have been obtained from them. The heterozygous plants show a fair degree of fertility, much less than do the shallow lobed plants. This type of deep lobing appears to be semilethal in the homozygous state, as such plants develop only rarely. Selfed heterozygous plants give ratios among their offspring approaching two deep to one shallow, more closely than three deep to one shallow (see Table 2c). Thus we have the following four types of plants in regard to deep lobing and male fertility; deep lobed and male sterile, deep lobed and partially male sterile which are semilethal in the homozygous state, deep lobed and male fertile; and shallow lobed and male fertile. No shallow lobed male sterile plants have been obtained.

There are at least three possible explanations for this breeding behavior. There may have been three independent mutations at different loci, one of which resulted in deep lobes with no effect on sterility, another which resulted in deep lobes and partial male sterility, and a third which resulted in deep lobes and complete male sterility. If true, plants heterozygous for any two of the three types of deep lobing should give three types of offspring when crossed with shallow lobed, male fertile plants. Two of such crosses have been made, as shown in Tables 2a and 2b.

TABLE 2

ANALYSIS OF DATA ON LEAF LOBING AND MALE STERILITY

A.

Deep ♂ sterile x heterozygous deep ♂ fertile.

12 deep ♂ sterile;
7 deep ♂ fertile;
8 shallow ♂ fertile.

Five of the deep ♂ sterile were crossed with shallow ♂ fertile.

One gave 30 offspring, all deep.
" " 32 " 17 deep, 15 shallow.
" " 17 " 8 deep, 9 shallow.
" " 5 " all deep.
" " 8 " 6 shallow, 2 deep.

B.

Deep ♂ sterile x heterozygous deep partially ♂ sterile.

2 deep completely sterile.
3 deep partially ♂ sterile.
2 deep ♂ sterile.
2 shallow ♂ fertile.

Two of the deep partially ♂ sterile, and one of the deep completely ♂ sterile were crossed with shallow ♂ fertile plants, and in each case produced offspring in the ratio of approximately 1 deep to 1 shallow.

C.

SEGREGATIONS OBTAINED BY SELFING HETEROZYGOUS DEEP LOBED PARTIALLY ♂ STERILE PLANTS

Sample	*Deep*	*Shallow*
1	10	5
2	11	3
3	8	3
4	25	12
5	28	15
6	10	2
Total	92	40

P
1 df X^2 value of deviation from 3 : 1 ratio = 1.979 0.3–0.05
X^2 " " " " 2 : 1 " = 0.544 0.5–0.3

In no instance were more than two types of offspring produced from such, definitely indicating that independent mutations cannot account for the variations.

It is possible that a single pair of alleles may be responsible for deep and shallow lobes, and another set of alleles responsible for variations in male sterility. If so, these two sets of alleles are so closely linked that they rarely, if ever, cross over. The other alternative is that the variations in both leaf lobes and male sterility are due to a single set of four multiple alleles, which may be represented as follows: L-deep male sterile, l^P-deep, partially male sterile, l^F-deep, male fertile and ll shallow, male fertile.

Which of these latter two hypotheses is correct could be established only by the appearance of a shallow lobed male sterile plant or a new mutation affecting both lobes and male sterility. It is apparent, however, that the genes affecting lobing and male sterility are at the same or almost the same chromosome locus.

TABLE 3

Data on Purple vs. Green Lower Epidermis

A.

Sample	*Purple*	*Green*
1	21	8
2	135	41
3	33	11
4	14	7
Total	203	67

B.

Backcross Segregations

Sample	*Purple*	*Green*
1	16	17
2	16	14
3	38	43
Total	69	74

TABLE 4

F$_2$ Segregations Green vs. White or Pink Areas

Sample	*Green*	*White or Pink Areas*
1	132	44
2	22	5
3	71	27
4	67	15
	292	91

TABLE 5

Heterozygous Faint Pattern Selfed

Faint	*Dark*	X^2	*df*	*P*
35	8	0.843	1	0.5-0.3

LOWER EPIDERMIS, CHLOROPHYLL DEFICIENCY AND FAINT PATTERNS

Lower leaf surfaces may be either purple or green. Purple lower leaf surfaces are usually associated with reddish stems and leaf veins. As shown in Table 3, backcrosses of purple x green lower epidermis give 1 : 1 ratios, and F$_2$ segregations of 3 purple to 1 green. Apparently, then, purple lower epidermis (B) is dominant to green (b).

White or pink spots, due to the absence of chlorophyll, are frequently found in the center of coleus leaves. The extent of these spots is variable, ranging from a narrow stripe along the midribs of the leaves, to areas covering almost the entire leaf surface. Crosses between solid green and chlorophyll deficient strains give solid green progeny, and in the F$_2$ ratios of approximately 3 solid green to 1 chlorophyll deficient, indicating that solid green (A) is dominant to this type of chlorophyll deficiency.

Faint patterns, as contrasted with distinct patterns shown in Figure 1, are sometimes found. Whether the pattern is distinct or faint apparently is independent of the type of green, and is determined by the type and distribution of anthocyanin. A faint patterned plant when selfed, produced offspring in the ratio of approximately 3 faint to 1 distinct, (Table 5), suggesting dominance of the faint pattern (O) to the distinct (o).

LINKAGE

At least eight sets of alleles are indicated as being responsible for the variations discussed in this paper. Of the 28 possible linkage relationships 11 have been tested, as shown in Table 6. In none of these tests do the ratios obtained deviate significantly from what one should expect on the basis of random assortment, thus giving no indication of linkage.

TABLE 6

TESTS FOR LINKAGE

A

Backcross, P and L allelic series.

Non-crossovers		*Crossovers*		X^2	*df*	*P*
29	34	23	20	4.537	3	0.3–0.05

B

Backcross, P and I allelic series.

Non-crossovers		*Crossovers*		X^2	*df*	*P*
22	23	30	21	4.075	3	0.3–0.05

C

Backcross, I and L allelic series.

Non-crossovers		*Crossovers*		X^2	*df*	*P*
26	32	17	31	5.959	3	0.3–0.05

D

Backcross, B and L series.

Non-crossovers		*Crossovers*		X^2	*df*	*P*
22	23	19	17	1.826	3	0.7–0.5

E

Backcross, A and L series.

Non-crossovers		*Crossovers*		X^2	*df*	*P*
20	14	19	28	4.924	3	0.3–0.05

F

Backcross, A and B series.

Non-crossovers		*Crossovers*		X^2	*df*	*P*
25	18	15	23	2.986	3	0.5–0.3

G

F_2 segregation, A and I series—Test for deviation from 9 : 3 : 3 : 1 ratio.

A_I_	A_ii	aaI_	aaii	X^2	*df*	*P*
107	25	34	10	2.704	3	0.5–0.3

H

F_2 segregation, B and I series—Test for deviation from 9 : 3 : 3 : 1 ratio.

B_I_	B_ii	bbIi	bbii	X^2	*df*	*P*
110	25	31	10	2.379	3	0.5–0.3

I

Cross of Iill x IiLl—Test for deviation from 3 : 1 : 3 : 1 ratio.

				X^2	*df*	*P*
27	12	30	12	1.070	3	0.95–0.7

J

Selfed plant of genotype OoLl—Test for deviation from 6 : 3 : 2 : 1 ratio.

				X^2	*df*	*P*
24	11	4	4	1.982	3	0.7–0.5

SUMMARY

1. Leaf patterns in coleus are due to the homozygous state (tt) of a pair of alleles. The heterozygous state (Tt) produces mottling or speckling, and the other homozygous state (TT) results in solid green. Solid green due to p^G is epistatic to both Tt and tt, while Tt and tt are epistatic to p.
2. Four genes, either closely linked or belonging to the same allelic series, are responsible for variations in leaf lobes and male sterility.
3. Purple lower epidermis of leaves is dominant to green, solid green leaf color is dominant to white or pink spots, and faint leaf patterns appear to be dominant to distinct leaf patterns.
4. Tests gave no evidence for linkage between P and I, P and C, P and L, B and L, B and A, B and I, A and I, A and L, I and L, and O and L.

LITERATURE CITED

Boye, C. E., and D. C. Rife. 1938. Genetic Studies of Coleus, No. I Jour. Hered., 29: 55–60.
Rife, D. C. 1940. Genetic Studies of Coleus, No. II Jour. Hered., 31: 293–296.
Boye, C. E. 1941. Genetics Studies of Coleus, No. III Jour. Genet., XLII: 191–196.

The Culture of Plant Tissues

Literature pertinent to plant tissue culture dates back for about a century, with the major progress having been made since 1930. The interest in this field has developed to the point that a methods book on the subject is needed. This has appeared in the form of "A Handbook of Plant Tissue Culture." A skilled technician in this field and one who has played a leading part in the development of this branch of plant science, Dr. Philip R. White, has prepared a guide which meets the needs felt by many students of experimental morphology and physiology. The philosophical and historical background is covered in the first two chapters. The third chapter deals with materials which may be successfully cultured. In a succeeding chapter detailed description is given of a suitable laboratory for such work. Equipment is discussed with suggestions for successful manipulation. Other chapters deal with the preparation of cultures, point out merits and demerits of various techniques. The preparation of appropriate synthetic nutrient media is clearly presented. Suggestions for growth measurements and their interpretation are presented in Chapter VIII. The last two chapters, IX and X, deal with the significance of plant tissue culture in relation to general physiology and to morphogenesis in plants. These two chapters are likely to encourage new students in the field.

An excellent bibliography containing 457 citations will be valued by all interested persons. A detailed index of subject matter is included. This book will serve as an efficient guide for all who are interested in the subject.—*G. W. B.*

A Handbook of Plant Tissue Culture, by Philip R. White. Pp. xiv+277; 71 illustrations. The Jaques Cattell Press, Lancaster, Pa. 1943. $3.75.

Biochemistry and Morphogenesis

New scientific books are continually being produced. Only rarely, however, does one of the calibre of Needham's Biochemistry and Morphogenesis make its appearance. It is a veritable encyclopedia of present day knowledge concerning biochemistry in relation to embryology. Some idea of the scope of the book may be gained from the observation that the bibliography covers 70 pages, and that data from over 600 scientific periodicals are cited. The book is composed of three parts. Part I, The Morphogenetic Substratum, is concerned with the chemical raw material of development, and the information gleaned from embryology relative to nutritional problems. Part II, The Morphogenetic Stimuli, discusses the roles of evocators and primary and second grade organizers in various animal groups. Sixty-five pages are devoted to genes and organizer phenomena. Part III, The Morphogenetic Mechanisms, gives comprehensive discussions of dissociability, heteraupesis, respiration, metabolism and polarity. Indices of plants, animals and genes mentioned are included. This book should prove to be an indispensable reference for up-to-date biologists.—*D. C, Rife.*

Biochemistry and Morphogenesis, by Joseph Needham. 800 pages, 328 illustrations, including 35 full page plates (4 in color). The Macmillan Company, Cambridge University Press Department, New York. 1942. $12.50.

A NEW ASYMMETRIC COSMARIUM[1]

CLARENCE E. TAFT,
Department of Botany,
The Ohio State University

Species of Cosmarium which are characterized by the asymmetric condition of the semicells are extremely rare. Rich, in a report on the "Algae from a Pan in Southern Rhodesia," published in the Trans. of the Royal Society of South Africa, Vol. 23, 1935, described *Cos. asymmetricum* and stated that it was the only species to her knowledge in which one-half of the semicell is not a reflection of the other. It is readily distinguished from *Cos. zygomorphicum* by the smooth cell wall and small size.

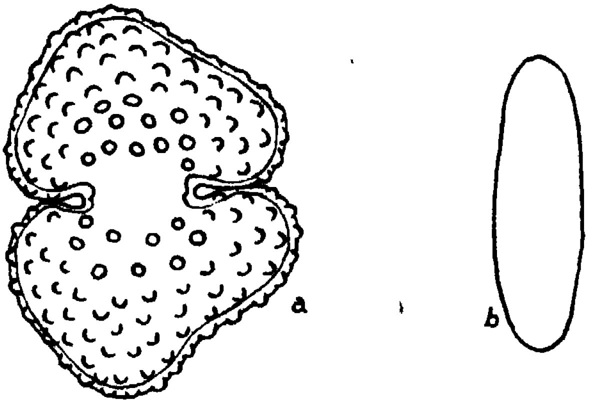


FIG. 1. *Cosmarium zygomorphicum* sp. nov.
a. Face view. b. Outline of cell in end view.

Cosmarium zygomorphicum sp. nov.

Cells of medium size, slightly longer than broad, deeply constricted, sinus closed. Semicells strongly asymmetrical, subpyramidate. End view narrowly elliptic. Cell wall coarsely granulate. One chloroplast with one pyrenoid in each semicell. L. 46–48μ; w. 35–37μ; isth. 10–13μ.

Semicellulis in aspectu frontali asymmetricis. Long. 46–48μ; lat. 35–37μ; isthm. 10–13μ.

Oklahoma, Puerto Rico, Indiana, Arkansas.

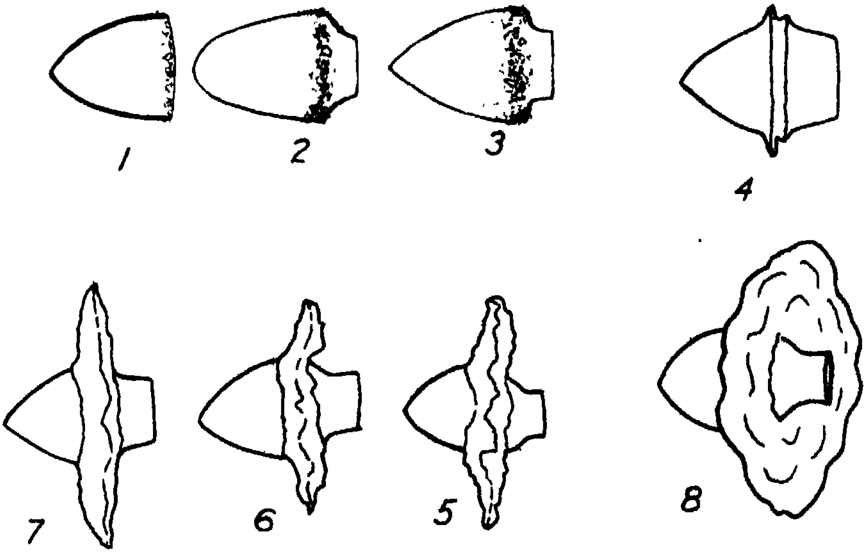
---

[1] Papers from the Department of Botany, The Ohio State University, No. 467.

A UNIQUE VARIANT OF CHRYSOCOCCUS ASPER LACKEY

JAMES B. LACKEY,
Senior Biologist, U. S. Public Health Service,
Cincinnati, Ohio

In January, 1941, several one liter samples of water were collected by the courtesy of Mr. Claudeous J. D. Brown, of the Michigan Institute for Fisheries Research, at various depths under the ice in Third Sister Lake. In April a second set of samples was collected. Both sets of samples were preserved with formalin and stored in the dark until sedimentation of all organisms and debris was complete. The contained microorganisms were then identified and counted. The first set contained 32 identifiable species of Algae and Protozoa; the second set 34; and the total in both sets was 47. Chrysophyceae accounted for 8 species in the first set, 3 in the second.



FIGS. 1-8. Variations in *Chrysococcus asper.* (1) Rough shoulder and neck, pointed shell; (2) Rough shoulder and neck, rounded shell; (3) No neck or shoulder, slightly roughened, pointed shell; (4) Form occasionally seen in rivers, with roughened area forming two small ridges; (5-8) Third Sister Lake variant showing wide flaring collar of the shoulder region.

Most of these were species of *Chrysococcus* which occurred from the surface to a depth of 50 feet. Among these was a type with a wide flaring collar encircling the shell a short distance behind its anterior opening. At first it was thought to represent a new species but careful observation of a large number showed it to be a variety of *C. asper.*

The genus *Chrysococcus* was founded by Klebs (1) with the type species *C. rufescens.* Pascher (2) added the species *punctiformis*, *Klebsianus*, *dokidophorus* and *ornatus*. Nauman (3) added the species *porifer* and *cordiformis* in 1921, and in 1938 and '39 the writer (4, 5) added seven species. These 14 species appear to comprise the genus as far as known. In all situations examined *rufescens*, *ovalis*, *cylindrica*, *asper* and *major* have been the most abundant. The writer has never seen *Klebsianus*, *dokidophorus*, *ornatus*, *porifer* and *cordiformis*. The species are rather clearly separated, although *rufescens* and *porifer* are close to each other, while *major* differs from *rufescens* principally in size and the lack of a posterior internal tubercle on the shell.

Usually the species do not exhibit a wide range of variation. *C. cylindrica* in the Licking River of Kentucky has shown rather divergent shell types, but all are clearly referable to the one species. *C. asper* has been perhaps the most variable. Its shell (Figures 1, 2, 3) may be pointed or rounded posteriorly, and there may be a constricted neck-like region, or the anterior end may be abruptly truncate. There is a tendency for one of these types to markedly predominate at any station where the species occurs in abundance.

Occasionally a form as shown in Figure 4 has been found. These have had the scabrous shell, but the roughening has extended to the formation of one or two small ridges encircling the shell in the shoulder region, ragged and uneven. Among the specimens from Third Sister Lake this region in many instances has become wide and flaring, forming a pronounced collar (Figures 5–8 incl.) so that single individuals might easily be mistaken for new species. There is a gradual transition, however, and it is apparent from studying a large number of individuals that all graduations exist between the typical *C. asper* types and the forms having the extreme collar. None-the-less no specimens were found in the April catches which were typical *C. asper* as in Figures 1 to 4; *C. rufescens* was abundant and *C. spiralis* occurred sparingly, but all others had wide collars as in Figures 5 to 8. If the intermediate forms in the January samples had been missed, there would have been a strong tendency to call the April forms of *C. asper* a new species.

These variants are an excellent example of variation in a given direction. *Chrysococcus* is apparently much more common to streams than to lakes, and this unusual type has not been encountered in streams. Third Sister Lake is deep, and the organism is photosynthetic; but to imagine the collar a flotation mechanism is futile, in view of its apparent added weight. We are thus left with another example of the query as to the cause of variation; and with a renewed caution against species creation without examining large numbers of the questionable new forms.

REFERENCES

(1) **Klebs, G.** 1892. Flagellatenstudien. Zeitschr. f. Wissenschaft Zoologie, 55: 353–445. 1892.
(2) **Pascher, A., and E. Lemmermann.** 1913. Die Susswasser-Flora Deutschlands, Osterreichs and der Schweiz. H. 2. Flagellatae 2. Gustav Fischer, Jana.
(3) **Naumann, Einar.** 1921. Notizen sur Systematik der Susswasseralgen. Arkiv. f. Botanik 16 (2): 1–19.
(4) **Lackey, James B.** 1938. Scioto River Forms of Chrysococcus. Am. Mid. Natur. 20 (3): 619–623.
(5) ———. 1939. Notes on Plankton Flagellates from the Scioto River. Lloydia, 2: 128–143.

The Development of Scientific Thought

This volume is the third edition of a successful treatment of the broad outlines of the development of scientific thought. The author holds that the study of such a history has much to teach both about the inner meaning of science itself and about its bearing on philosophy and religion. In this edition, not only has a new chapter been added covering the years 1930–1940, but extensive changes have been made in the original text. The older part includes chapters on the science of the ancient world, the middle ages, the renaissance, the Newtonian epoch, and the nineteenth century. The approach is scholarly, but eminently readable. A strong philosophical theme pervades the historical account. The scientist in any field can not fail to have a broader and deeper understanding of his chosen life-work after reading the book.

L. H. Snyder.

A History of Science, by Sir William Cecil Dampier. xxiii+574 pp. Cambridge, at the University Press; New York, the Macmillan Co. 1942. $2.95.

A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART—AVES V—SPHENISCIFORMES

PART I[1]

FRED H. GLENNY,[2]
1148 Linden Avenue, Akron, Ohio

During 1941 and 1942 the writer had the opportunity of carrying out studies on the arrangement-patterns of the main arteries in the neck and thorax of five species of Penguins. This study was greatly facilitated by materials made available to him by the Division of Birds, United States National Museum, and the Department of Ornithology, Royal Ontario Museum of Zoology.

The materials for this study included single specimens of the Rock-hopper Penguin ***Eudyptes crestatus*** (Miller), the "Johnny" Penguin ***Pygoscelis papua*** (Forster), Humboldt's Jackass Penguin ***Spheniscus humboldti*** (Meyen), the Galapagos Penguin ***Spheniscus mendiculus*** (Sundevall), and one immature and two adult specimens of the Black-footed Penguin ***Spheniscus demersus*** (Linné).

Routine dissections and diagrams of the arterial arrangement in the neck and thorax were made. The information thus obtained is set forth in the following observations.

OBSERVATIONS

The basic arrangement-pattern of the Spheniscidae is exemplified by ***Eudyptes crestatus*** (Miller), and ***Spheniscus demersus*** (Linné), (Figure 1).

The aortic root (1) arises in the left ventricle of the heart, passes anteriorly and to the right before it divides to form the left and right innominate arteries (2) which in turn pass anteriorly and laterally to give rise to the subclavian (9) and common carotid (8) arteries. Shortly after the bifurcation of the aortic root, the right innominate artery sends off the right systemic (4th aortic) arch (3) which passes dorsally and posteriorly to join the right radix aortae (4). The radix aortae then passes diagonally posteriorly toward the central axis of the body where it continues as the dorsal aorta (23). At the point of junction between the radix and the dorsal aorta, the ligamentous vestige of the left radix aortae (ligamentum aortae) (5) may be found passing anteriorly and diagonally toward the left pulmonary artery.

In some species of birds (Beddard; Glenny, 1939, 1940, 1942a, 1943) the left radix aortae presents a lumen which can be injected for some of its length. For the most part, however, it remains as the ligamentum aortae (5) (Glenny, 1942b, 1943) which may or may not maintain its anterior connection with the pulmonary artery (7).

As has already been noted in an earlier paper (Glenny, 1943) the left ligamentum botalli almost or completely atrophies after the left radix aortae anastomoses with the left pulmonary (6th aortic) arch during middle embryogeny (the time of anastomosis varies in different species of birds). The right ligamentum botalli (6), therefore, alone remains as the vestige of the distal portion of the embryonic 6th aortic arch. This vestige lies along the ventral or ventro-lateral face of the right radix and generally maintains its proximal and distal connections.

The subclavian arteries (9) give rise to the coracoid major (10), axillary (11), intercostal (12), and two pectoral (13) arteries in order. The coracoid major (10) gives rise to a short sterno-tracheal (24) artery, and the axillary artery (11) sends off the coracoid minor (25) artery. The intercostal artery branches to form the

---

[1] Contributions from the Department of Zoology, University of Toronto.

[2] Formerly Assistant, Department of Zoology, University of Toronto. Now on Active Service, U. S. Army.

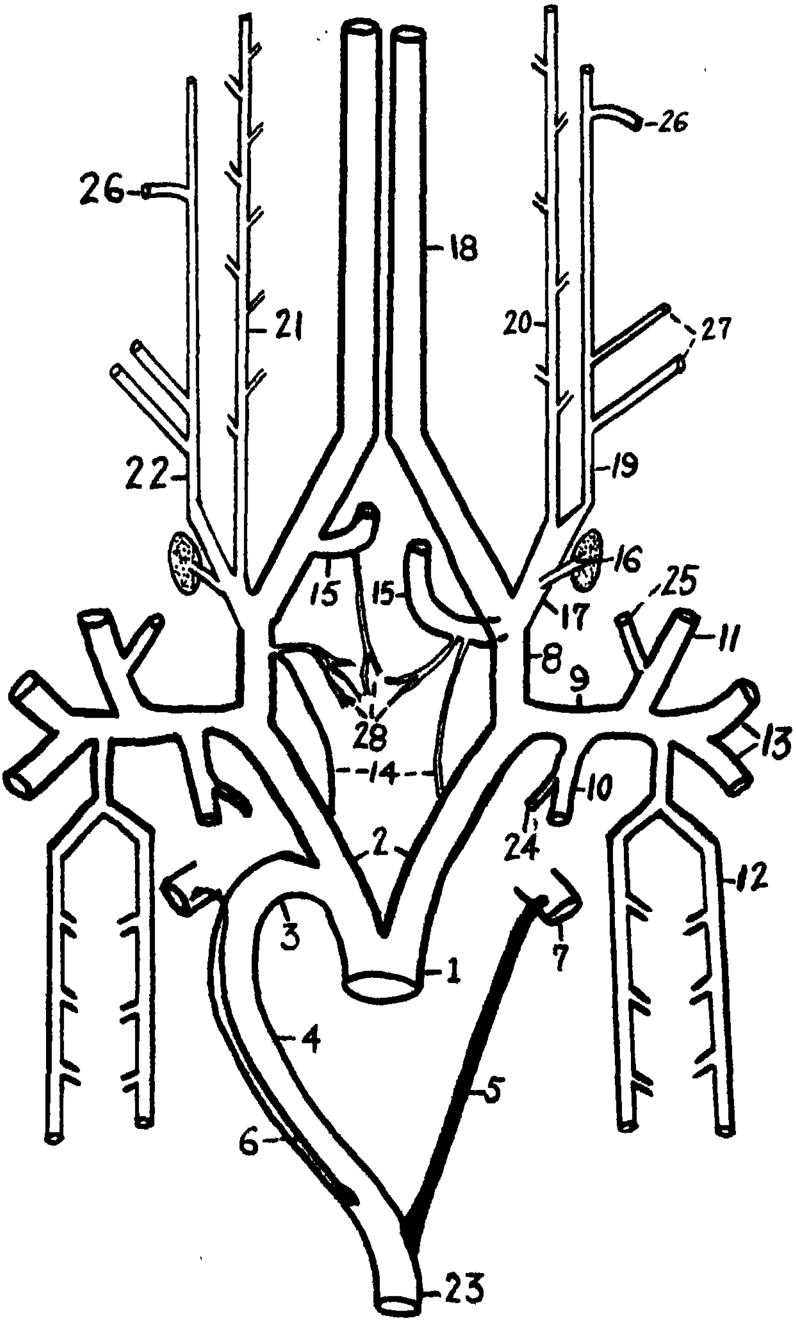


FIG. 1. Diagrammatic representation of the arrangement of arteries in the neck and thorax of *Spheniscus demersus* (Linné). Ventral view.

Key to Abbreviations of Fig. 1: 1, aortic root; 2, innominate arteries; 3, right systemic arch; 4, right radix aortae; 5, ligamentum aortae; 6, ligamentum botalli; 7, pulmonary artery; 8, common carotid artery; 9, subclavian artery; 10, coracoid major artery; 11, axillary artery; 12, intercostal artery; 13, pectoral arteries; 14, ductus shawi; 15, vertebral arteries; 16, thyroid artery; 17, superficial cervical artery (root); 18, internal carotid artery; 19, dorso-lateral cervical artery; 20, ventro-lateral cervical artery; 21, ascending-oesophageal artery; 22, dorso-lateral cervical artery; 23, dorsal aorta; 24, sterno-tracheal artery; 25, coracoid minor artery; 26, subscapular artery; 27, basi-cervical arteries; 28, tracheo-oesophageal arteries.

ventral and lateral rami. The ventral intercostal usually lies along or near the line of articulation between the ribs and sternum, while the lateral intercostal lies more dorsally (midway) along the inner surface of the ribs.

Anteriorly, the common carotid arteries (8) give rise to the thyroid (16), vertebral (15), internal carotid (18), and superficial cervical arteries. The thyroid arteries arise in the region of the carotid junction at which point the common carotid divides to form the internal carotid, vertebral, and superficial cervical arteries. The ductus shawi arises either from the common carotid or from the vertebral artery near its origin on the common carotid. Both left and right ductus shawi pass posteriorly, dorsal to the heart, sending off branches to the trachea, syrinx, oesophagus, and fascia of the thorax dorsal to the heart. The superficial cervical root divides into two smaller branches, a ventro-lateral branch which supplies the lymphatic glands and musculature on the left side, and the oesophagus, lymphatics, and musculature on the right side of the neck; and a more dorsal vessel which sends off several branches to the base of the neck (27), and a subscapular artery (26) before passing anteriorly to supply the cervical musculature. Both left and right internal carotid arteries (18) enter the hypapophysial canal and the condition is referred to as bicarotidinae normales (Garrod). As these vessels pass anteriorly they send off small segmental arteries and finally divide to form the several branches of the internal and external carotid arteries in the region of the head.

In *Eudyptes crestatus*, the left radix aortae remains as the ligamentum aortae (Glenny, 1943). The distal portion of the right 6th aortic arch presents a small lumen for about three-fourths of its length (may be due to immaturity of the specimen) while the rest remains as the occluded vestige.

Pygoscelis papua presents the same basic pattern as *Eudyptes* with but slight differences. The distal portion of the left radix aortae remains patent for most of its length. The right ductus botalli becomes atrophied and remains as the ligamentum botalli.

Although one specimen was but four days old, *Spheniscus demersus* presents a similar arrangement to *Eudyptes*. In each of the three specimens studied, the distal portion of the left radix aortae and right ductus botalli remain as ligaments.

The arrangement of these arteries in *Spheniscus mendiculus* is the same as in the other species studied. The distal portion of the right 6th aortic arch remains as a ductus botalli (probably a juvenile specimen), while the left radix becomes atrophied and persists as the ligamentum aortae.

It is readily seen that the species of Penguins studied show the same basic arrangement-pattern of neck and thoracic arteries, and that all of these present at least ligamentous vestiges of the left radix aortae and right ductus arteriosus. It may also be reasoned that, since a lumen is found to be present in at least two specimens, atrophy of the left radix and right ductus botalli probably occurs only during the latter part of their embryonic development.

REFERENCES

Beddard, F. E. 1898. The Structure and Classification of Birds. London, Longmans, Green and Co.

Garrod, A. H. 1873. On the Carotid Arteries of Birds. London, Proc. Zool. Soc., pp. 457–472.

Glenny, F. H. 1939. An Anomalous Artery in the Kingfisher (*Ceryle alcyon*). Columbus, Ohio Jour. Sci., 39(2): 94–96.

1940. A Systematic Study of the Main Arteries in the Region of the Heart—Aves I. Phila., Anat Rec., 76(4): 371–380.

1942a. A Systematic Study of the Main Arteries in the Region of the Heart—Aves III. Columbus, Ohio Jour. Sci., 42(2): 84–90.

1942b. Main Arteries in the Region of the Neck and Thorax of the Australian Cassowary. Ottawa, Can. Jour. Res. O, 20: 363–367.

1943. A Systematic Study of the Main Arteries in the Region of the Heart—Aves IV. England, Proc. Zool. Soc. London. (In press.)

STUDIES IN THE BIOLOGY OF THE LEECH[1]

VII. A New Method of Staining Nervous Tissue

JOHN A. MILLER,
Department of Zoology and Entomology,
The Ohio State University,
Columbus, Ohio

The technique presented in this paper employs certain elements of the original Golgi method, combined with the working principle of the reduced silver method of Cajol. The accompanying illustrations demonstrate how effectively this technique differentiates the histological as well as the cytological details of the nervous system of the leech.[1] This method has in common with that of Golgi's the useful character of staining only some of the neurons. The stained portions are impregnated with the reduced silver compound showing clearly their structure and pattern. The nerve cells and their processes are black against a light blue background. Muscle or connective tissue cells, where appearing in the same field, are tinted red. If a counter stain is used color variations will be noted.

Miller's Method, Variants A and B

DETAILS OF PROCEDURE

1. *Relaxing.*

   The leech was placed in a shallow dish containing a 0.1 per cent chloretone solution to which had been added a pinch of protoletic enzyme. Caroid was found to be satisfactory. This latter, while not absolutely necessary, materially aided in disposing of the copious mucous secreted by the organism. After five minutes in the chloretone solution, there was added drop by drop, a saturated solution of the same until the leech was completely relaxed. It was then placed in a wax bottom dissecting pan. Here the leech was pinned to normal size and received the first application of the killing and fixing agent.

2. *Killing and Fixing.*

   A solution of 10 per cent formalin was used as a killing and fixing medium. The usual time of fixation was twenty-four hours. The animal was then washed thoroughly in tap water and in several changes of distilled water.

3. The leech was dissected at this point. A ventral strip of body wall was frequently left attached for orientation. A completely dissected nerve trunk was pinned on a strip of heavy paper bent to form a bow.

4. The tissue was then immersed in 3 per cent potassium dichromate for two weeks, then

5. Rinsed in several changes of distilled water.

6. The tissue was then placed in 1 per cent solution of silver nitrate; after a precipitate formed the tissue was transferred to a fresh solution of 1 per cent silver nitrate for 1 week.

7. Rinsed in several changes of distilled water.

---

[1] *Haemopis marmoratis* (Say).

8. *Dehydration.*

   In the dehydration of material for celloidin imbedding it was necessary to insure absolute removal of all water. The following procedure proved to be adequate for parts of the nervous system of small sections of the animal. Beginning with 30 per cent alcohol the material was carried through 50–70–80–95–100 per cent alcohol for a minimum of two hours each. Two changes of two hours each in absolute alcohol-ether completed the process.

9. *Infiltration and Embedding.*

   Following dehydration the tissue was placed in 10 per cent celloidin for eight hours and left overnight in 15 per cent celloidin. The material to be mounted was supported by a block of hardened celloidin and oriented within a mould formed by surrounding the fiber cutting block with gum paper. The cutting block mould was then filled with 15 per cent celloidin; the tissue oriented and hardened under a bell jar. Chloroform was used to complete the gardening process. When completely hardened the block was placed in thin cedar wood oil where it remained until sectioned. (In the procedure outlined above the block of tissue did not exceed one centimeter in length.)

10. Sections were cut to desired thickness. (Cedar wood oil was used in preference to alcohol during the cutting process.)

11. Sections were placed in thin cedar wood oil, where they were kept until ready to proceed with the next step. Sections were kept serially by separates. At this point two alternative procedures were followed.

VARIANT A

12A. Sections gradually hydrated and placed in

13A. Six per cent silver nitrate for four days (in the dark).

14A. Washed in several changes of distilled water.

15A. Reduced in the following mixture for 24 hours: (In the dark.)

Hydroquinone	2.0 g.
Neutral formalin	20.0 cc.
Water (distilled)	200.0 cc.

16A. Washed in several changes of distilled water.

17A. (Optional). Tone in 0.2 per cent gold chloride, 30 minutes.

18A. Washed in distilled water.

19A. Fixed in 5 per cent hypo-sulphite of soda, 30 seconds.

20A. Washed in distilled water.

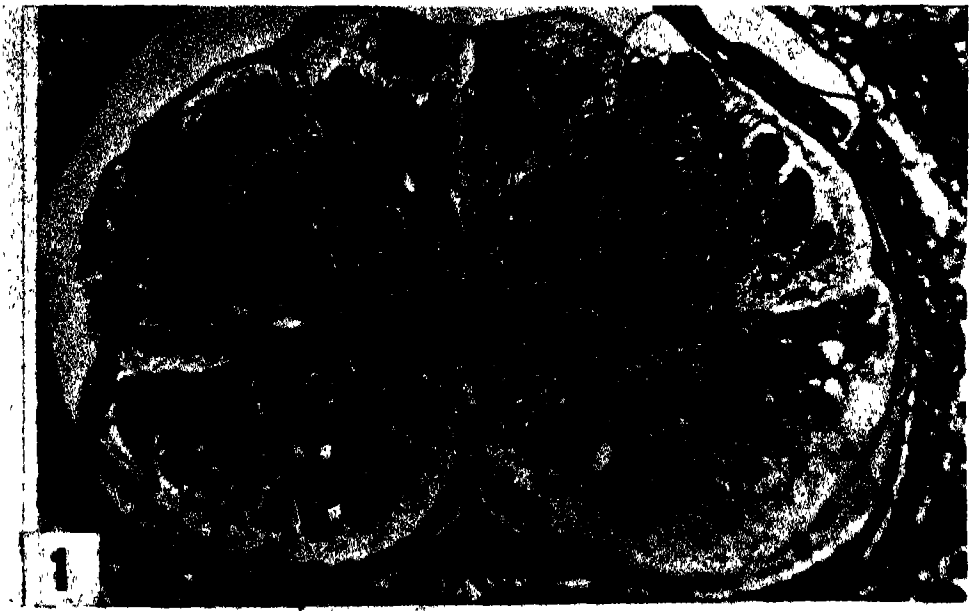
21A. (Optional). Counter stain at this point if desired.

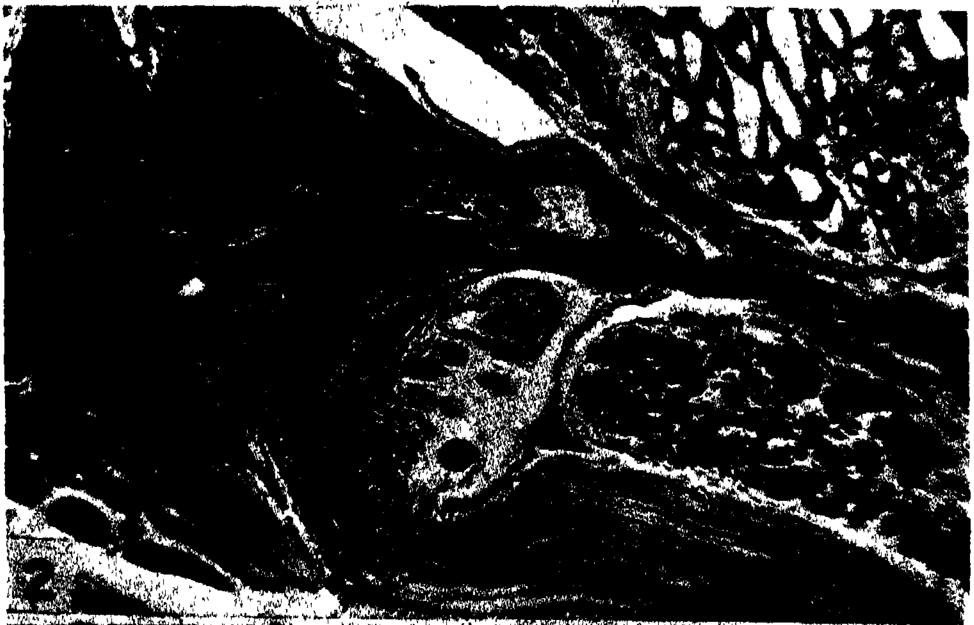
22A. Dehydrate, clear, mount in clarite. (Follow standard procedures which will vary according to type of counter stain used.)

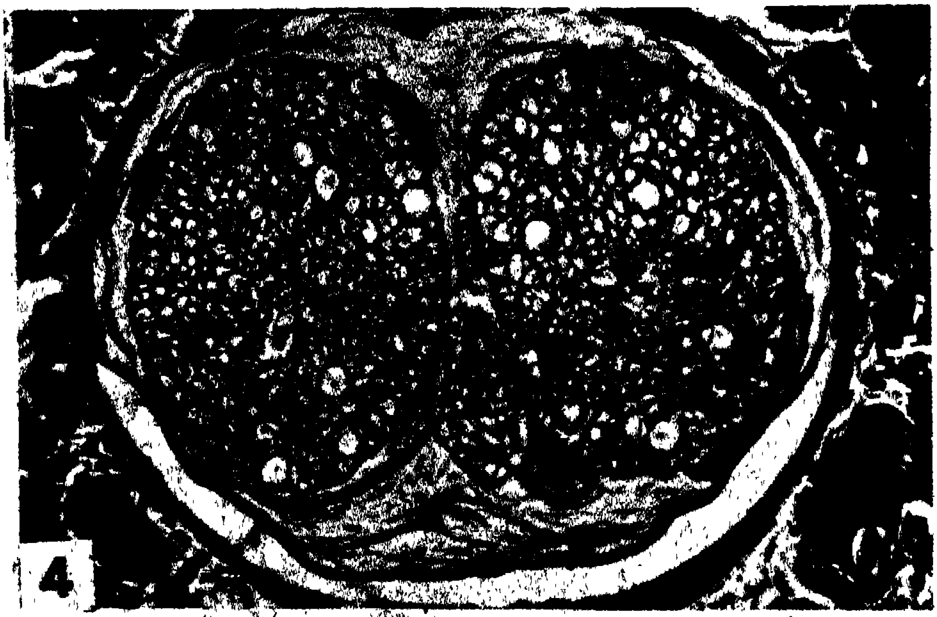
EXPLANATION OF PLATE I

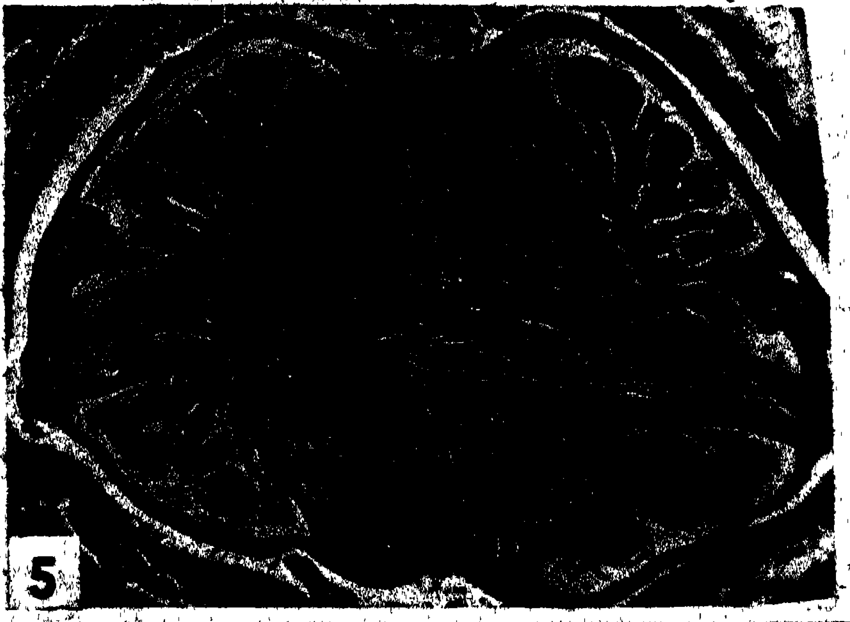
FIG. 1. Photomicrograph—Method A. Cross-section through a ganglion.
FIG. 2. Photomicrograph—Method A. Frontal section through a ganglion.
FIG. 3. Photomicrograph—Method A. Longitudinal section through the caudal ganglion.

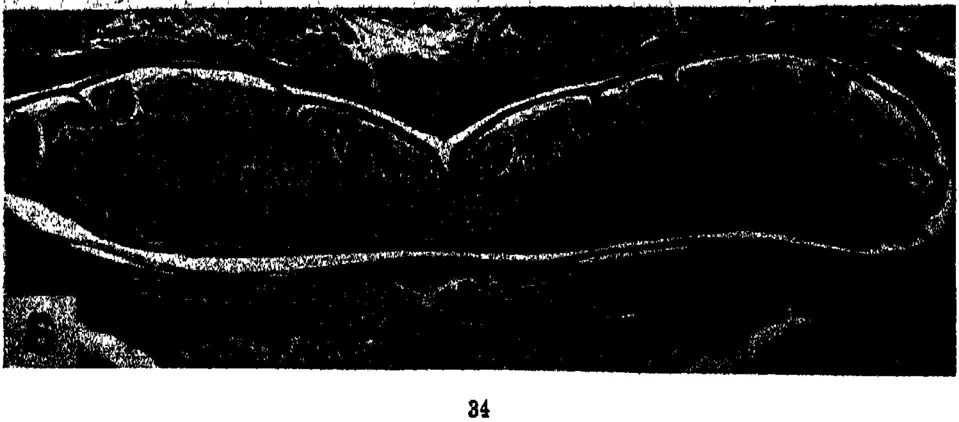
PLATE I






4


5



VARIANT B

12B. Sections from cedar wood oil were gradually hydrated and placed in
13B. 20 per cent silver nitrate solution 60–90 minutes.
14B. Washed quickly in distilled water and placed in
15B. Ammoniated silver nitrate, 3 minutes.

The above solution was prepared by adding concentrated aqua ammonia, drop by drop, to 20 per cent silver nitrate solution until the precipitate is almost dissolved. The mixture was then filtered. (The ammoniated silver nitrate must be freshly prepared and can be used only once.)

16B. Washed quickly in distilled water.
17B. Sections were placed in 10 per cent formalin one minute.
18B. Washed in several changes of distilled water.
19B. Toned in 2.0 per cent gold chloride 10 minutes.
20B. Washed in distilled water.
21B. (Optional procedure.) Reduce in 2.0 per cent oxalic acid + 1 cc. of formalin per 100 cc. of solution, 20 seconds.
22B. Washed in distilled water.
23B. Fixed in 5.0 per cent of hypo-sulphite of soda, 2 minutes.
24B. Washed in distilled water.
25B. (Optional.) Counter stain at this point if desired.
26B. Dehydrate, clear, mount in clarite. (Follow standard procedures which will vary according to type of counter stain used.)

Counter staining was successfully employed following either of the above procedures. Mayer's acid hematoxylin and eosin or haemalum gave good cellular differentiation. Mallory's phosphotungstic acid hematoxylin was very effective following either of the above variations Follow standard procedures for counter staining and subsequent treatment.

Method A produced the best material for histological study, particularly noted in the longitudinal and frontal sections.

Method B was especially useful in cytological study, being particularly valuable in the study of ganglion cells.

The writer is preparing a manuscript of "Modifications in Neurological Microtechnique," as applied to leech material. This paper will appear in an early issue of this Journal.

REFERENCES

Guyer, Michael F. 1936. Animal Micrology. University of Chicago Press Illinois.

Lee, Bolles. 1937. The Microtomist's Vade-Mecum Edit. Gatenby and Painter, 10th Edition, Churchill, London.

McClung, C. E. and others. 1937. Handbook of Microscopical Technique, 2nd Revised Edition. Hoeber, New York.

EXPLANATION OF PLATE II

FIG. 4. Photomicrograph—Method B. Cross-section through a nerve cord.
FIG. 5. Photomicrograph—Method B. Cross-section through a ganglion.
FIG. 6. Photomicrograph—Method B. Cross-section through the dorsal cephalization.

PERMANENT PRESTAINING IN BOTANICAL MICROTECHNIC[1]

EUGENE B. WITTLAKE,
The Ohio State University, Columbus, Ohio

One of the many problems in botanical microtechnic is the retainment of safranin at the proper intensity and brilliance when counterstaining with fast green FCF or any of the commonly used counterstains. Especially is it difficult when attempting to stain plant tissues previously treated with hydrofluoric acid.

The term "permanent" is used here for the lack of a better word and to distinguish this type of staining from ordinary procedures. The most common prestaining is a process of staining bulk material so that it can be easily seen in the paraffin block or ribbon. In permanent prestaining, the bulk material is stained once and the stain used in prestaining becomes the primary stain of the finished preparation.

In this instance a specific method was sought, which would be suitable for the staining of bluegrass leaves in transverse section. By using this type of prestaining, several days may be added to the dehydration process; however, time is saved from imbedding to the finished preparation.

The preparation of bluegrass leaves by this technic is relatively simple but certain procedures must be adhered to if the desired results are to be obtained. First, the leaves are cut transversely with a sharp razor blade into one-eighth inch lengths. If they are cut any longer uneven penetration of the dye is unavoidable. Also, siliceous compounds will not be uniformly removed when treated with hydrofluoric acid.

OUTLINE OF PROCEDURE

1. Place material in formal-acetic-alcohol (using 70 per cent ethyl alcohol), or Bouin's Fluid, and by means of a vacuum pump or an apparatus similar to Wittlake's (2) vacuum apparatus, pump at 600 mm. mercury for 12 hours.
2. Rinse quickly in distilled water and transfer to commercial hydrofluoric acid (48 per cent)[2], 120 hours.
3. Remove material from the hydrofluoric acid and wash in running tap water for one hour.
4. Transfer material to Johansen's (1) 50 per cent Tertiary Butyl Alcohol. Pump one hour at 600 mm. mercury.
5. Stain in Safranin Y[3] made up according to Johansen's (1) procedure of preparing Safranin O with methocellosolve. Stain from 96 to 120 hours.
6. Dehydrate by Johansen's (1) Tertiary Butyl Alcohol method up to 100 per cent at intervals of two hours.
7. Transfer to 10, 25, 50, 70, 85, 95, 100 per cent toluene series made up in tertiary butyl alcohol at two-hour intervals.
8. Transfer to equal parts of xylene and toluene, and finally to 100 per cent xylene. Change at two-hour intervals.
9. Place specimen bottle in the imbedding oven for one-half hour, allowing the xylene to warm up. Infiltrate in a good grade of rubber paraffin by adding paraffin to the xylene at several three-hour intervals and pouring off half the volume of the mixture

---

[1] Papers from the Department of Botany, The Ohio State University, No. 463.

[2] The hydrofluoric acid used is obtainable from J. T. Baker Chemical Co., Phillipsburg, New Jersey, in ¼-lb. (113.4g) paraffin container at a concentration of 48 per cent.

[3] The Safranin Y used was manufactured by the Coleman and Bell Co., Norwood, Ohio, certification No. C S-7.

each time until no odor of xylene can be detected. If a vacuum is used in the infiltrating process only four or five changes will be necessary before all the xylene is removed.

10. Section material at 10 microns and remove paraffin from slide with xylene, which will occur within about 5 minutes.
11. Transfer to equal parts of xylene and absolute alcohol for 45 seconds, agitating the slide constantly.
12. Transfer to absolute ethyl alcohol for 45 seconds and continue agitation.
13. Counterstain with Johansen's Fast Green FCF[3] 30 to 45 seconds and agitate.
14. Transfer slides to Johansen's (1) Fast Green Rinse for one minute with vigorous agitation. (This is made up of one part xylene, one part clove oil and one part 100 per cent ethyl alcohol.)
15. Clear in synthetic methyl salicylate two minutes.
16. Complete in two changes of xylene at two-minute intervals.
17. Mount in xylene balsam or clarite.

Acceptable finished preparations, from tissues fixed in formal-acetic-alcohol, were obtained, showing very little plazmolysis and both the primary stain and the counterstain were up to standard as to brilliance and intensity. However, Bouin's Fluid proved to be the preferred fixative for this particular leaf tissue. When using either of these fixatives, fixation was accomplished in a twelve-hour interval under vacuum at 600 mm. mercury.

Since it is almost impossible to cut satisfactorily the leaves of many grasses without first removing the silica, a commercial grade of hydrofluoric acid was used so that the material could be sectioned easily in paraffin. Of course, all containers in which this acid is used should be first paraffined on the inside, as well as the cork used for the container. A standard 50 cc. wide-mouthed bottle is sufficient for most material. Care should be taken not to breathe the fumes of this acid. When the material becomes translucent to opaque in appearance, it is ready to be removed from the acid. This is usually from 96 to 120 hours. All material in this experiment was treated for 120 hours.

In this staining method, the proper staining time of the bulk material was determined by selecting the material which showed after prestaining, a minimum of diffusion of the dye into the mesophyl of the leaf from the vascular strands. The bulk material selected in this way turned out to be the same material that was acceptable when carried through the above schedule to the finished preparation. A decrease or increase in the timing of the counterstain altered the acceptability of the finished slide. When a counterstain time was secured with bulk material of these characteristics and showed the proper balance between the safranin and the fast green in the finished preparation, this counterstain time was used as the standard time. When bulk material was selected which showed a great amount of diffusion of the dye into the mesophyl, it was impossible to vary the counterstain time sufficiently to produce a satisfactory finished preparation. The same thing was true in the case of bulk material that was understained.

In the safranin-fast green combination, the balance between the two stains changes even with the particular tissue being stained; hence alterations in the timing of stains in most of the general staining schedules is necessary. A safranin-fast green combination which is not up to standard can be detected by definite gradations of red to purple and blue to green from parts of tissue which should stain a brilliant red to parts of tissue which stain a brilliant green color. In other words, a well differentiated preparation should show definite areas of green and red.

The writer has found that the range in time intervals between strictly alcoholic safranin and alcoholic fast green is much longer than the staining time interval between Johansen's (1) Metho-cellosolve safranin and Johansen's Metho-cellosolve fast green. However, when the proper time interval is obtained with Johansen's stains, they yield excellent results. Although, these time intervals between Johansen's safranin and fast green are more difficult to balance properly without obtaining blue and purple gradations of color, it would seem that a beginner would have more success with alcoholic safranin-fast green schedules.

---

[3] The Fast Green FCF used was manufactured by the National Aniline and Chemical Co., Inc., New York, New York, certification No. NG f-4, dye content 91 per cent.

In this particular procedure the writer has used only a part of Johansen's Tertiary Butyl Alcohol Dehydration Method When 100 per cent tertiary butyl alcohol was reached, the material was transferred to 10 per cent toluene made up in 100 per cent tertiary butyl alcohol. This was done to avoid the use of paraffin oil in Johansen's schedule. Paraffin oil is extremely hard to extract from plant tissues once it gains entrance The author, as well as several of his associates, have tried Johansen's Tertiary Butyl Alcohol Dehydration Method with no success. When ready to cut infiltrated material where there is a trace of paraffin oil left in the tissues, it is almost impossible to get a satisfactory ribbon.

Toluene was used with 100 per cent tertiary butyl alcohol and after extended use of this particular combination of liquids, it was found that a minimum of hardening of tissues resulted. The lack of brittleness was very apparent in contrast to material run through a long series of xylenes and ethyl alcohols.

Although this staining procedure was worked out specifically for bluegrass leaves it has been successfully used on other material. Many other tissues not treated with hydrofluoric acid were also used with the result that safranin was retained easily and to a very high intensity. Another observation is that material permanently prestained by this method can be left in the dehydration alcohols much longer than in regular staining schedules.

REFERENCES

(1) **Johansen, D. A.** 1940. Plant Microtechnique. McGraw-Hill, New York, N. Y.
(2) **Wittlake, E. B.** 1942. An efficient vacuum apparatus for microtechnic. Ohio Journal of Science, 42: 65-69.

So You Want to Be a Chemist

"A chemist is more or less a human being, though not always behaving like one, who is going to come to be welcomed in more and more fields of business activity and industry as people learn more about him and as he in turn learns more about people."—so Dr. Coith defines (describes) a chemist. With similar frankness and "shop-talk language" he develops his theme: The Work of the Chemist in Standards, Research, Plant Development and Products Service; he then discusses The Kind of Chemists Industry Wants, The Kind of Industries Chemists Want, and The Chemist in Wartime. The discussion is general enough to hold one's interest, but specific enough to give a helpful point of view on pertinent questions by a successful industrial chemist. This is a very helpful book to have on every teacher's book shelf where it will be handy to loan to the young person interested in *industrial* chemistry. But to be fair to the youth and to the field of chemistry, such counsellors should also have a companion book to present the work of the chemist in universities and in the great research foundations, those areas unfortunately are not treated in this book.—*A. B. Garrett.*

So You Want to Be a Chemist, Herbert Coith. 128 pages. McGraw-Hill Book Company, New York. 1943.

Taxidermy

This new book on taxidermy, although small, is sufficient to satisfy the needs of amateurs and most teachers. The book is carefully written and nicely illustrated. Detailed directions are given specifically for the mounting of a deer head, a fish, bird, wildcat, squirrel, tortoise, horned toad and a crayfish A list of tools and necessary materials is given with suggestions for possible substitutions.—*G. W. B.*

Taxidermy, by Leon L. Pray. 91 pp., 45 illustrations. Macmillan Company, New York, 1943. $1 49.

FRESHWATER CHLOROPHYCEAE AND XANTHOPHYCEAE FROM PUERTO RICO

L. H. TIFFANY AND M. E. BRITTON,
Northwestern University,
Evanston, Ill.

It was the plan of the late Dr. Marshall Avery Howe of the New York Botanical Garden to publish comprehensive surveys of the freshwater algae of Puerto Rico Some of these have already appeared. The analysis of the samples of algae collected by the Norwegian algologist, N. Wille, during the last week of December, 1914, and the first three months of 1915, were to have formed a part of these reports. The collection of Professor Wille, submitted to us by Dr. Howe some ten years ago, has now been quite thoroughly explored for recognizable Chlorophyceae and Xanthophyceae. Preliminary reports have been made by Wille (1915) and Tiffany (1936). In the latter, one genus and fourteen species were described as new, and the descriptions of three others were emended.[1]

This paper lists four species and varieties of Xanthophyceae and 228 species and varieties of Chlorophyceae. The latter group includes 35 species and varieties previously listed for Puerto Rico (Lagerheim, 1887; Moebius, 1888), but not found by the present writers; and 11 species and varieties previously listed by the above named and also appearing in Wille's collections.[2] It has seemed best to include these older records here, and names have been changed accordingly to conform with modern synonomy

The writers express their appreciation to Dr E N. Transeau and to Dr C E. Taft, of the Ohio State University, for their generous assistance in the identification of certain Zygnemataceae and Desmidiaceae; and to the staff of the New York Botanical Garden for the opportunity of studying this valuable collection. Translation of Wille's field notes was made by Dr Howe.

XANTHOPHYCEAE

HETEROCOCCALES

Ophiocytiaceae

Ophiocytium capitatum Wolle

In pool near park, Santurce, Dec. 25; in brook near the Experiment Station, Rio Piedras, Dec. 28.

O. parvulum (Perty) A. Braun

In pool near park, Santurce, Dec. 25, Feb 3; east of Humacao, Jan. 23; in pool about four kilometers north of Mayaguez, Feb. 24

Botryococcaceae

Centritractus belonophorus Lemm.

In pool near park, Santurce, Dec. 25.

HETEROTRICHALES

Tribonemataceae

Tribonema bombycinum var. tenue (Hazen) Tiffany

In ditch, Jayuya, Mar. 15.

---

[1] These algae are indicated in the systematic listing by prefacing an asterisk to each name.

[2] Many of the species recorded by Moebius are too uncertain to be recognized. All of Lagerheim's records of Chlorophyceae are included here, except *Desmidium baileyi* (Ralfs) Nordst. var. *quadrangulatum*, *Staurastrum quadrangulare* Breb. var. *attenuatum* Nordst., and *Cosmarium meneghini* Breb. *f.* Delp, which we have not been able to place accurately.

CHLOROPHYCEAE

VOLVOCALES

Phacotaceae

Phacotus lenticularis (Ehr.) Stein
West of Humacao, Jan. 21.

Volvocaceae

Gonium pectorale Muell.
Caguas, Jan. 16.

Pandorina morum Bory
In a pool near the park, Santurce, Dec. 25; in pool west of Humacao, Jan. 21.

TETRASPORALES

Palmellaceae

Gloeocystis ampla Kuetz.
Caguas, Jan. 17; west of Humacao, Jan. 22; east of Humacao, Jan. 23; in pool near Borinquen Park, Santurce, Feb. 3; in pool about 4 kilometers north of Mayaguez, Feb. 24; in pool between Hatillo and Arecibo, Feb. 27; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

Sphaerocystis schroeteri Chodat
In stream about 5 kilometers east of Coamo, Jan. 8; east of Humacao, Jan. 23; in pool near Borinquen Park, Santurce, Feb. 3; in pool about 4 kilometers north of Mayaguez, Feb. 24.

(?) **Urococcus insignis** (Hass.) Kuetz.
On water plants, east of Humacao, Jan. 23. Identified only by size and the character of the stratified gelatinous sheath. The red coloration characteristic of the species was not evident in the preserved material.

Tetrasporaceae

Schizochlamys gelatinosa A. Braun
At Maricao, Feb. 21.

Tetraspora gelatinosa (Vauch.) Desv.
In stream about 5 kilometers east of Coamo, Jan. 8.

T. lubrica (Roth) Ag.
In stream about 5 kilometers east of Coamo, Jan. 8; in brook west of Humacao, Jan. 21.

ULOTRICHALES

Ulotrichaceae

Binuclearia tatrana Wittr.
In river at Utuado, Mar. 5.

Stichococcus flaccidus (Kuetz.) Gay
Reported by Wille but not seen by present writers.
On palm roots in ditch south of Mayaguez, Feb. 11; on wood on way to Monte Montoso, Maricao, Feb. 13; on earth between Hato Arriba and Arecibo, Mar. 1.

Ulothrix aequalis Kuetz.
In river at Utuado, Mar. 5.

U. zonata (Weber & Mohr) Kuetz.
In Turabo River, Caguas, Jan. 17; in ditch on way to the Playa, Fajardo, Feb. 27; in ditch south of Mayaguez, Feb. 11; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

Microsporaceae

Microspora tumidula Hazen
In brook on way to San Lorenzo, Jan. 18; in brook west of Humacao, Dec. 21; in stream west of Humacao, Jan. 22.

M. willeana Lag.
In stream about 5 kilometers east of Coamo, Jan. 8; in river at Utuado, Mar. 5.

Chaetophoraceae

Chlorotylium cataractum Kuetz.
In stream about 5 kilometers east of Coamo, Jan. 8; in Coamo River, about 5 kilometers south of Coamo Springs, Jan. 10.

***Cloniophora capitellata** Tiffany
Near reservoir west of Experiment Station, Rio Piedras, Dec. 31; in brook on the road

northward from Maricao, Feb. 20; in water basin west of Experiment Station, Rio Piedras, Mar. 23; on stone in river north of Maricao, Feb. 22.

***C. willei** Tiffany
On the dam by water reservoir, Rio Piedras, Dec. 31.

Protoderma viride Kuetz.
In pool, Jayuya, Mar. 15; on Oedogonium in water basin west of Experiment Station, Rio Piedras, Mar. 23.

Stigeoclonium attenuatum (Hazen) Collins
In water basin west of Experiment Station, Rio Piedras, Mar. 23.

S. nanum (Dillw.) Kuetz.
On water plants in ditch south of Mayaguez, Feb. 11.

S. stagnatile (Hazen) Collins
In stream east of Humacao, Jan. 23; on stone in stream, Humacao, Jan. 24; on gutter stone, Mayaguez, Feb. 25.

S. tenue (Ag.) Kuetz.
On bark of a stick in water east of Humacao, Jan. 23.

Protococcaceae

Pleurococcus vulgaris Naeg. non Menegh.
On old bark in railroad station, Naguabo, Jan. 25; on bark in shady wood, Maricao, Feb. 21.

Coleochaetaceae

***Coleochaete disjuncta** Tiffany
In pool near Borinquen Park, Santurce, Feb. 3.

C. irregularis Pringsh.
In pool about 4 kilometers north of Mayaguez, Feb. 24.

C. pulvinata A. Braun
In pool about 4 kilometers north of Mayaguez, Feb. 24.

C. scutata Breb.
In pool near park, Santurce, Dec. 25; on water plants near reservoir west of Experiment Station, Rio Piedras, Jan. 8; in a stream about 5 kilometers east of Coamo, Jan. 17; on stems of Potamogeton in Turabo River, Caguas, Jan. 23; on water plants in a stream east of Humacao, Jan. 23; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

Trentepohliaceae

Cephaleuros virescens Kunze
On leaves, Coamo Springs, Jan. 14; on water plants in stream west of Humacao, Jan. 22; on leaves near Laguna Tortuguero, Feb. 5.

Gongrosira viridis Kuetz.
In stream about 5 kilometers east of Coamo, Jan. 8.

Leptosira mediciana Borzi
On roots in woods, Coamo Springs, Jan. 12. Identified by Wille.

Phycopeltis epiphyton Mill. (*Phyllactidium tropicum* Moebius) Moebius (1888)
On tree, Coamo Springs, Jan. 10; on citrus leaves near La Juanita, Feb. 9 (collected by E. G. Britton); on palm leaf at La Juanita, Feb. 9.

Trentepohlia aurea (L.) Mart.
On reservoir wall west of Experiment Station, Rio Piedras, Jan. 2; on old wood, Hacienda Catalina, Palmar, Jan. 29; on concrete fountain and bark in woods on way to Monte Montoso, Maricao, Feb. 13; on bark near "Campo," Maricao, Feb. 19; on bark about 5 kilometers north of Utuado, Mar. 8; on bark, Arroyo de los Corchos, Mar. 13.

T. elongata (Zeller) DeToni
In a brook near Rio Piedras, Dec. 27; in brook near Experiment Station, Rio Piedras, Dec. 28.

***T. santurcensis** Tiffany
On palm bark in park, Santurce, Dec. 24.

***T. willei** (Tiffany) Printz (*Nylandera willei* Tiffany)
On leaves north of Maricao, Feb. 22.

Cladophoraceae

Cladophora crispata (Roth) Kuetz.
Moebius (1888). Collected at Cabo and in river and brook at Coamo.

C. glomerata (L.) Kuetz.

Moebius (1888). Collected on rocks in Marillos River at Cayey.

Generally distributed in streams and rivers. About 5 kilometers east of Coamo, Jan. 8; near Coamo Springs, Jan. 11; Caguas, Jan. 16; on way to San Lorenzo, Jan. 18; water basin west of Experiment Station, Rio Piedras, Mar. 23. The species shows considerable variation in appearance and shape of cells, but to try to recognize separate varieties seems unwise.

Pithophora mooreana Collins

In water reservoir, Rio Piedras, Dec. 28; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

P. oedogonia (Mont.) Wittr.

In pool between Hatillo and Arecibo, Feb. 27

P. varia Wille

In water reservoir, Rio Piedras, Dec. 28; in pool about 4 kilometers north of Mayaguez, Feb. 24; in pool, Jayuya, Mar. 15; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

Rhizoclonium fontanum Kuetz. (*R. fontinale* Wolle)

Moebius (1888). Collected in Morillos River, Cayey.

In brook, Hacienda Catalina, Palmar, Jan. 29; in a cement water-holder, Coral Veijo, 12 kilometers north of Ponce, Mar. 12.

R. hieroglyphicum (Ag.) Kuetz.

Generally distributed in pools, brooks and rivers. Near Rio Piedras, Dec. 27, 28; west of Humacao, Jan. 22; in Laguna Tortuguero, Feb. 5; about 4 kilometers north of Mayaguez, Feb. 24; about 5 kilometers north of Utuado, Mar. 8; in ditch between Utuado and Adjuntas, Mar 10; Jayuya, Mar. 15; water basin west of Experiment Station, Rio Piedras, Mar. 23.

OEDOGONIALES

Oedogoniaceae

Bulbochaete elatior Pringsh.

On water plants in Turabo River, Caguas, Jan. 17; stream east of Humacao, Jan. 23.

B. intermedia DeBary

On water plants in river east of Humacao, Jan. 23.

***Oedocladium operculatum** Tiffany

On ground, Juan Martin, Jan. 28; on earth in garden near Sabana Grande, Mayaguez, Feb. 9.

Oedogonium abbreviatum (Hirn) Tiffany

On water plants in brook near Rio Piedras, Dec. 24; in Coamo River about 5 kilometers south of Coamo Springs, Jan. 10; in pool between Hatillo and Arecibo, Feb. 27.

***O. brittoni** Tiffany

In Coamo River near Coamo Springs, Jan. 11, Mar. 20.

O. cardiacum var. **carbonicum** Wittr.

In a stream about 5 kilometers east of Coamo, Jan. 8.

O. crispum (Hass.) Wittr.

On water plants in brook west of Humacao, Jan. 21.

O. cyathigerum Wittr.

In water basin west of Experiment Station, Rio Piedras, Mar. 23.

O. decipiens var **dissimile** (Hirn) Tiffany

On water plants in Turabo River, Caguas, Jan. 17; in pool near Borinquen Park, Santurce, Feb. 3.

O. exospirale Tiffany

On roots of *Eichornia crassipes* in river, Caguas, Jan. 16.

***O. figuratum** Tiffany

On roots of *Eichornia crassipes* and other water plants in river, Caguas, Jan. 16; on water plants in brook west of Humacao, Jan. 21; in pool between Hatillo and Arecibo, Feb. 27.

O. flexuosum Hirn

On roots of water plants in river at Utuado, Mar. 5; in pool by river about 5 kilometers north of Utuado, Mar. 8.

O. foveolatum Wittr.

In brook on way to San Lorenzo, Jan. 18; in pool between Hatillo and Arecibo, Feb. 27; in ditch along the road, about 12 kilometers north of Utuado, Mar. 6.

O. gracilius (Wittr.) Tiffany

In water basin west of Experiment Station, Rio Piedras, Mar. 23.

O. gracillimum Wittr. & Lund.

On water plants in brook west of Humacao, Jan. 21.

O. grande Kuetz.
On water plants in brook west of Humacao, Jan. 21.

***O. howardii** G. S. West
In stream about 5 kilometers east of Coamo, Jan. 8, 16; in pool near Borinquen Park, Santurce, Feb. 3; in pool between Hatillo and Arecibo, Feb. 27; on rocks, Jayuya, Mar. 15; in Coamo River, Mar. 20.

***O. howei** Tiffany
In pool between Hatillo and Arecibo, Feb. 27.

O. hystricinum Transeau & Tiffany
In pool near Borinquen Park, Santurce, Feb. 3

O. illinoiense Transeau
On roots of *Eichornia crassipes* in river, Caguas, Jan. 16.

O. inconspicuum Hirn
In pool near park, Santurce, Dec. 25; in a pool near Borinquen Park, Santurce, Feb 3.

O. intermedium Wittr.
In ditch 12 kilometers north of Utuado, Mar. 6.

O. inversum Wittr.
Laguna Guanica, Mar. 17.

O. kurzii G. Zeller
In pool by river, 5 kilometers north of Utuado, Mar. 8.

O. laetevirens Wittr.
In pool between Hatillo and Arecibo, Feb. 27.

***O. lageniforme** Hirn
In water reservoir west of Experiment Station, Rio Piedras, Jan. 2.

O. latiusculum Tiffany
In water reservoir west of Experiment Station, Rio Piedras, Jan. 2; in Coamo River, about 5 kilometers south of Coamo Springs, Jan. 10.

O. latviense (Tiffany) Tiffany
On water plants near reservoir west of Experiment Station, Rio Piedras, Dec. 31; on water plants by bridge, Caguas, Jan. 16; in stream west of Humacao, Jan. 22.

O. lemmermannii Tiffany
In stream about 5 kilometers east of Coamo, Jan. 28.

O. macrandrium var. **hohenackerii** (Wittr.) Tiffany
In pool between Hatillo and Arecibo, Feb. 27.

O. macrandrium var. **propinquum** (Wittr.) Hirn
In brook on way to San Lorenzo, Jan. 18; in pool between Hatillo and Arecibo, Feb. 27.

O. monile Berk. & Harv.
In pool near Mayaguez, Feb. 24.

O. nanum Wittr.
On water plants in pool between Hatillo and Arecibo, Feb. 27.

O. obesum Wittr.
In pool near park, Santurce, Dec. 25; in brook on way to San Lorenzo, Jan. 18; in brook west of Humacao, Jan. 21.

O. obtruncatum Wittr.
On water plants by bridge, Caguas, Jan. 16; in ditch south of Mayaguez, Feb. 11; on water plants in pool between Hatillo and Arecibo, Feb. 27; in pool, Jayuya, Mar. 15.

O. paulense Nordst. & Hirn
In pool near Borinquen Park, Santurce, Feb. 3.

O. perfectum (Hirn) Tiffany
In ditch south of Mayaguez, Feb. 11.

O. pringsheimii Cramer
On water plants in brook west of Humacao, Jan. 21; in pool between Arecibo and Hatillo, Feb. 27; in river at Utuado, Mar. 5.

***O. rugulosum** var. **rotundatum** (Hirn) Tiffany.
In pool near Borinquen Park, Santurce, Feb. 3; in pool between Hatillo and Arecibo, Feb. 27.

***O. santurcense** Tiffany
In pool near Borinquen Park, Santurce, Feb. 3.

O. senegalense (Nordst.) Tiffany
In pool near Borinquen Park, Santurce, Feb. 3.

***O. subareolatum** Tiffany
In pool near Borinquen Park, Santurce, Feb. 3.

O. wolleanum Wittr.
In water reservoir, Rio Piedras, Dec. 28.

O. wyliei Tiffany
On water plants in brook west of Humacao, Jan. 21.

ULVALES

Schizomeridaceae

Schizomeris leibleinii Kuetz.
Generally distributed, often on water plants and stones in pools, ditches, streams and reservoirs. Near Rio Piedras, Dec. 27, 31; 5 kilometers east of Coamo, Jan. 8; Caguas, Jan. 16; on way to San Lorenzo, Jan. 18; west of Humacao, Jan. 21; east of Humacao, Jan. 23; Farjardo, Jan. 27; Hacienda Catalina, Palmar, Jan. 29; South of Mayaguez, Feb. 11; 4 kilometers north of Mayaguez, Feb. 24; Mayaguez, Feb. 25; between Hatillo and Arecibo, Feb. 27; Utuado, Mar. 5; Ponce, Mar. 12; Jayuya, Mar. 15.

In some collections there appeared a Schizomeris whose general habit was somewhat unlike that of the species above, but until more data are available, it does not seem desirable to attempt a separation.

SCHIZOGONIALES

Schizogoniaceae

Schizogonium murale Kuetz.
On rocks between Utuado and Adjuntas, Mar. 10.

CHLOROCOCCALES

Hydrodictyaceae

Pediastrum duplex Meyen
In pool near park, Santurce, Dec. 25; in a stream about 5 kilometers east of Coamo, Jan. 8; in pool near Borinquen Park, Santurce, Feb. 3.

P. tetras (Ehr.) Ralfs (*P. ehrenbergii* A. Br.)
Lagerheim (1887). Collected at Fajardo and Caguas.
Moebius (1888).
In stream about 5 kilometers east of Coamo, Jan. 8; on water plants by bridge, Caguas, Jan. 16; on water plants in Turabo River, Caguas, Jan. 17; in stream east of Humacao, Jan. 23; in pool near Borinquen Park, Santurce, Feb. 3; in Coamo River, Mar. 20; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

P. tetras var. **tetraodon** (Corda) Hansgirg
In a stream about 5 kilometers east of Coamo, Jan. 8.

Sorastrum americanum (Bohlin) Schmidle
In pool near the park, Santurce, Dec. 25; in stream about 5 kilometers east of Coamo, Jan. 8; on water plants in Turabo River, Caguas, Jan. 17; in pool near Borinquen Park, Santurce, Feb. 3.

S. bidentatum Reinsch
Lagerheim (1887). Collected at Fajardo.

S. spinulosum Naeg.
In a stream about 5 kilometers east of Coamo, Jan. 8; on water plants in Turabo River, Caguas, Jan. 17; in pool near Borinquen Park, Santurce, Feb. 3.

Coelastraceae

Coelastrum cambricum Archer
In a pool near park, Santurce, Dec. 25; on water plants in Turabo River, Caguas, Jan. 17.

C. microporum Naeg.
In pool near park, Santurce, Dec. 25; on water plants in Turabo River, Jan. 17; in brook on way to San Lorenzo, Jan. 18; Caguas, Jan. 19; in pool near Borinquen Park, Santurce, Feb. 3; in Laguna Tortuguero, Feb. 5; in Coamo River, Mar. 23; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

C. morus var. **capense** Fritsch.
In rock depression in river near Maricao, Feb. 15; on rocks between Utuado and Adjuntas, Mar. 10.

C. proboscideum Bohlin
In river near Maricao, Feb. 15.

Oocystaceae

Ankistrodesmus falcatus (Corda) Ralfs (*Raphidium polymorphum* Fresen.)
Lagerheim (1887). Collected at Fajardo.

Dimorphococcus lunatus A. Braun
In a pool near park, Santurce, Dec. 25; on water plants in Turabo River, Caguas, Jan. 17; in pool near Borinquen Park, Santurce, Feb. 3.

Gloeotaenium loitlesbergerianum Hansgirg
In Laguna Tortuguero, Feb. 5.

Kirchneriella lunaris (Kirchner) Moebius
In Laguna Tortuguero, Feb. 5.

Nephrocytium obesum West
On water plants in Turabo River, Caguas, Jan. 17.

Oocystis solitaria Wittr.
Lagerheim (1887). Collected at Fajardo.
Moebius (1888).

Selenastrum bibraianum Reinsch
On water plants in Turabo River, Jan. 17.

S. **bibraianum** var. **gracile** (Reinsch) Tiffany & Ahlstrom
On water plants in Turabo River, Caguas, Jan. 17.

Tetraedron minimum (A. Br.) Hansgirg
In stream about 5 kilometers east of Coamo, Jan. 8; on water plants by bridge, Caguas, Jan. 16; on water plants in Turabo River, Caguas, Jan. 17; on water plants in brook west of Humacao, Jan. 21; in rock depression in river near Maricao, Feb. 15; in pool about 4 kilometers north of Mayaguez, Feb. 24; on rocks on way to Jayuya, Mar. 15.

T. **minimum** f. **tetralobulatum** Reinsch
In stream about 5 kilometers east of Coamo, Jan. 8; in rock depression in river near Maricao, Feb. 15; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

T. **muticum** (A. Br.) Hansgirg
In pool about 4 kilometers north of Mayaguez, Feb. 24.

T. **pentaedricum** W. & G. S. West
On water plants in Turabo River, Caguas, Jan. 17.

T. **regulare** Kuetz.
In pool near park, Santurce, Dec. 25; in rock depression in river near Maricao, Feb. 15.

T. **regulare** var. **bifurcatum** Wille (*Polyedrium tetraedricum* var. *bifurcatum* Wille)
Lagerheim (1887). Collected at Fajardo.

T. **regulare** var. **torsum** Turner
In a pool near the park, Santurce, Dec. 25.

T. **trigonum** (Naeg.) Hansgirg
In pool about 4 kilometers north of Mayaguez, Feb. 24.

Scenedesmaceae

Scenedesmus abundans (Kirchner) Chodat
In a pool near park, Santurce, Dec. 25, Feb. 3.

S. **acuminatus** (Lag.) Chodat
In pool near Borinquen Park, Santurce, Feb. 3.

S. **acutiformis** Schroeder
In pool near park, Santurce, Dec. 25; in Turabo River, Caguas, Jan. 17; in stream east of Humacao, Jan. 23; in pool near Borinquen Park, Santurce, Feb. 3; in pool near river, 5 kilometers north of Utuado, Mar. 8.

S. **arcuatus** var. **platydisca** G. M. Smith
On water plants in Turabo River, Caguas, Jan. 17; in pool about 4 kilometers north of Mayaguez, Feb. 24.

S. **armatus** (Chodat) G. M. Smith
In pool about 4 kilometers north of Mayaguez, Feb. 24.

S. **armatus** var. **bicaudatus** (Guglielmetti) Chodat
In brook on way to San Lorenzo, Jan. 18.

S. **armatus** var. **exaculeatus** Chodat
In stream about 5 kilometers east of Coamo, Jan. 8; on water plants east of Humacao, Jan. 23; in river, Fajardo, Jan. 26; in Laguna Tortuguero, Feb. 5; in water basin west of Experiment Station, Rio Piedras, Mar. 23.

S. **bijuga** (Turp.) Lagerheim
In pool near park, Santurce, Dec. 25; in water reservoir, Rio Piedras, Dec. 28; in stream about 5 kilometers east of Coamo, Jan. 8; in pool near Borinquen Park, Santurce, Feb. 3; in pool about 4 kilometers north of Mayaguez, Feb. 24; in pool by river, about 5 kilometers north of Utuado, Mar. 8,

S. bijuga var. **alternans** (Reinsch) Borge
Lagerheim (1887). Collected at Fajardo.
In a stream about 5 kilometers east of Coamo, Jan. 8; in a river near Maricao, Feb. 15.

S. brasiliensis Bohlin
In pool near park, Santurce, Dec. 25; on water plants in Turabo River, Caguas, Jan. 17; on water plants in river, Fajardo, Jan. 26; on stone in river, Fajardo, Jan. 27; in pool near Borinquen Park, Santurce, Feb. 3; in rock depression in river near Maricao, Feb. 15; in pool by river, about 5 kilometers north of Utuado, Mar. 8.

S. brasiliensis var. **norvegicus** Printz
In pool near Borinquen Park, Santurce, Feb 3.

S. dimorphus (Turpin) Kuetz.
In stream about 5 kilometers east of Coamo, Jan. 8; in rock depression in river near Maricao, Feb. 15; in pool by river about 5 kilometers north of Utuado, Mar. 8; on rocks on way to Jayuya, Mar. 15; in pool, Jayuya, Mar. 15; in swamp, Jayuya, Mar 15; in pool, Jayuya, Mar. 15.

S. hystrix Lagerheim
Lagerheim (1887). Collected at Fajardo and Caguas

S. incrassatulus var **mononae** G. M. Smith
In stream about 5 kilometers east of Coamo, Jan. 8; in rock depression in river near Maricao, Feb. 15.

S. obliquus (Turp.) Kuetzing
In pool near park, Santurce, Dec. 25; in stream about 5 kilometers east of Coamo, Jan. 8; on water plants in Turabo River, Caguas, Jan. 17; in pool near Borinquen Park, Santurce, Feb. 3; in pool by river about 5 kilometers north of Utuado, Mar. 8.

S. quadricauda (Turp.) Breb.
In pool near Borinquen Park, Santurce, Dec. 25, Feb. 3; in stream about 5 kilometers east of Coamo, Jan 8; on water plants in Turabo River, Caguas, Jan. 17; in Laguna Tortuguero, Feb. 5; in pool about 4 kilometers north of Mayaguez, Feb. 24; in pool between Hatillo and Arecibo, Feb. 27; among water plants in pool, Jayuya, Mar. 15.

S. quadricauda var. **maximus** W. & G. S West
In Laguna Tortuguero, Feb. 5.

S. quadricauda var. **quadrispina** (Chodat) Smith
In pool near Borinquen Park, Santurce, Dec. 25; in stream about 5 kilometers east of Coamo, Jan. 8; in pool about 4 kilometers north of Mayaguez, Feb. 24.

SIPHONALES

Vaucheriaceae

Vaucheria sessilis (Vauch.) DC.
In ditch between Utuado and Adjuntas, Mar. 10.

ZYGNEMATALES

Zygnemataceae

Mougeotia calcarea (Cleve) Wittrock
In Laguna Tortuguero, Feb. 5.

M. globulispora Jao
In stream about 5 kilometers east of Coamo, Jan. 8.

M. tumidula Transeau
In ditch near Laguna Joyuda, Mayaguez, Feb. 18.

***Pleurodiscus borinquenae** Tiffany
In river near Hacienda Catalina, Palmar, Jan. 29, 31; in Laguna Tortuguero, Feb. 5; near Maricao, Feb. 13; near Jayuya, Mar. 15.

Sirogonium sticticum (Engl. Bot.) Kuetz.
On moist earth by brook west of Humacao, Jan. 22.

Spirogyra daedalea Lagerheim
In a stream about 5 kilometers east of Coamo, Jan. 8.

S. decimina (Mueller) Kuetz.
In pool near park, Santurce, Dec. 25; in stream about 5 kilometers east of Coamo, Jan. 8; in alluvial slime in Coamo River, about 5 kilometers south of Coamo Springs, Jan. 10; in ditch, Humacao, Jan. 20 ; in pool about 4 kilometers north of Mayaguez, Feb. 24; in river at Utuado, Mar. 5; in pool by river, about 5 kilometers north of Utuado, Mar. 8.

S. discreta Transeau
In a stream about 5 kilometers east of Coamo, Jan. 8.

S. emilianensis Bonhomme
In brook on way to San Lorenzo, Jan. 8; in stream west of Humacao, Jan. 22; in Rio Grande, near Sabana Grande, Feb. 9; in Coamo River by Coamo Springs, Mar. 19.

S. farlowii Transeau
In a stream about 5 kilometers east of Coamo, Jan. 8; in pool 5 kilometers north of Utuado, Mar. 8.

S. fluviatilis Hilse
In stream west of Humacao, Jan. 22, in pool about 4 kilometers north of Mayaguez, Feb. 24.

***S. hatillensis** Transeau
In pool between Hatillo and Arecibo, Feb. 27.

S. hyalina Cleve
In brook on way to San Lorenzo, Jan. 18; in ditch south of Mayaguez, Feb 11.

S. inflata (Vauch.) Rabenhorst
In stream about 5 kilometers east of Coamo, Jan. 8.

S. majuscula Kuetzing
In pool between Hatillo and Arecibo, Feb. 27.

S. minor (Schmidle) Transeau
In stream about 5 kilometers east of Coamo, Jan. 8.

S. neglecta (Hassall) Kuetzing
In Coamo River near Coamo Springs, Jan. 11.

S. nitida (Dillw.) Link
In brook, Hacienda Holm, Mayaguez, Feb. 17.

***S. quadrilaminata** Jao
In a stream about 5 kilometers east of Coamo, Jan. 8.

S. schmidtii W. & G. S. West
In pool about 4 kilometers north of Mayaguez, Feb. 24.

S. subrecticulata Fritsch
In water reservoir, Rio Piedras, Dec. 28, in stream about 5 kilometers east of Coamo, Jan. 8; in ditch south of Mayaguez, Feb 11; in river north from Maricao, Feb. 22.

S. triplicata (Collins) Transeau
In Coamo River near Coamo Springs, Jan. 11; in brook on way to San Lorenzo, Jan. 18.

S. tropica (W. & G. S. West) Transeau
In stream about 5 kilometers east of Coamo, Jan. 8; in Coamo River near Coamo Springs, Feb. 11; in brook on way to San Lorenzo, Jan. 18; in ditch south of Mayaguez, Feb. 11; in pool between Hatillo and Arecibo, Feb. 27; in pool by river, about 5 kilometers north of Utuado, Mar. 8.

S. varians (Hass.) Kuetzing
In pool by river, about 5 kilometers north of Utuado, Mar. 8.

S. weberi Kuetzing
In stream about 5 kilometers east of Coamo, Jan. 8.

Mesotaeniaceae

Gonatozygon monotaenium DeBary
In water reservoir west of Experiment Station, Rio Piedras, Jan. 2.

Desmidiaceae

Arthrodesmus subulatus f. americana (Turn.) W. & G. S. West (*A. incus* var. *americanus* Turn.)
Lagerheim (1887). Collected at Fajardo.

Closterium dianae Ehr.
Lagerheim (1887) Collected at Fajardo.

C. ehrenbergii Menegh.
On water plants in brook near Rio Piedras, Dec. 27.

C. lanceolatum Kuetz.
In Coamo River near Coamo Springs, Jan. 11.

C. leibleinii Kuetz.
Lagerheim (1887). Collected at Fajardo.
In water reservoir west of Experiment Station, Rio Piedras, Jan. 2; on water plants in Turabo River, Caguas, Jan. 17.

C. moniliferum (Bory) Ehr.
On water plants in brook near Rio Piedras, Dec. 27; by water reservoir west of Experiment Station, Rio Piedras, Dec. 31, Jan. 2; on water plants by bridge, Caguas, Jan. 16; in river, Caguas, Jan. 16; in brook on way to San Lorenzo, Jan. 18; in brook west of Humacao, Jan 21, 22.

C. **parvulum** Naeg.
In a pool near park, Santurce, Dec. 25; on water plants in brook near Rio Piedras, Dec. 27, 28; on water plants in river, Caguas, Jan. 16.

C. **rostratum** Ehr.
In brook on way to San Lorenzo, Jan. 18.

C. **tumidum** Johnson
In pool near park, Santurce, Dec. 25.

C. **turgidum** var. **giganteum** Nordst.
Lagerheim (1887). Collected at Caguas.

Cosmarium arctoum var. **tatricum** Racib.
Lagerheim (1887). Collected at Fajardo.

C. **biauritum** Nordst.
Lagerheim (1887). Collected at Fajardo.

C. **bireme** Nordst.
Lagerheim (1887). Collected at Fajardo.

C. **circulare** Reinsch
On water plants in brook and near reservoir near Rio Piedras, Dec. 27, 31; in brook west of Humacao, Jan. 21.

C. **circulare** f. **minor** W. & G. S. West
On water plants near reservoir west of Experiment Station, Rio Piedras, Dec. 31.

C. **contractum** Kirch.
In Turabo River, Caguas, Jan. 17.

C. **cucumis** (Corda) Ralfs (*Pleurotaeniopsis cucumis* Lagerheim)
Lagerheim (1887). Collected at Fajardo.

C. **granatum** Breb.
Lagerheim (1887). Collected at Caguas.
In brook and water reservoir near Experiment Station, Rio Piedras, Dec. 27, 28, 31, Jan. 2; in stream about 5 kilometers east of Coamo, Jan. 8; on water plants by bridge, Caguas, Jan. 16; on water plants in Turabo River, Caguas, Jan. 17; in brook on way to San Lorenzo, Jan. 18.

C. **humile** var. **substriatum** (Nordst.) Schmidle
On water plants in Turabo River, Caguas, Jan. 17.

C. **laeve** Rab.
In stream 5 kilometers east of Coamo, Jan. 8.

C. **lundellii** var. **ellipticum** West
In stream about 5 kilometers east of Coamo, Jan. 8.

C. **margaritatum** (Lund.) Roy and Biss. (*C. latum* var. *margaritatum* Lund.)
Lagerheim (1887). Collected at Fajardo and Caguas.

C. **meneghini** Breb.
In pool near park, Santurce, Dec. 25.

C. **meneghini** f. **latiuscula** Jacobs
Lagerheim (1887). Collected at Caguas.

C. **moniliforme** (Turp.) Ralfs
Lagerheim (1887). Collected at Fajardo and Caguas.

C. **moniliforme** f. **punctata** Lagerheim
Lagerheim (1887). Collected at Fajardo.

C. **obtusatum** Schmidle
In stream about 5 kilometers east of Coamo, Jan. 8.

C. **phaseolus** Breb.
Lagerheim (1887). Collected at Fajardo.

C. **pokornyanum** (Grun.) W. & G. S. West (*Euastrum angustatum* Wittr.)
Lagerheim (1887). Collected at Fajardo.

C. **portianum** Arch.
On water plants in Turabo River, Caguas, Jan. 17.

C. **pseudoconnatum** Nordst. (*Pleurotaeniopsis pseudoconnatus* (Nordst.) Lag.)
Lagerheim (1887). Collected at Fajardo.
On water plants in Turabo River, Caguas, Jan. 17.

C. **pseudoexiguum** Racib. (*Pleurotaeniopsis pseudoexigua* (Racib.) Lag.)
Lagerheim (1887). Collected at Fajardo.

C. **pseudonitudulum** Nordst.
In a stream about 5 kilometers east of Coamo, Jan. 8.

C. **punctulatum** Breb.
On water plants in Turabo River, Caguas, Jan. 17.

C. **regnesii** Reinsch
Lagerheim (1887). Collected at Fajardo.

C. **subcostatum** Nordst.
Near reservoir west of Experiment Station, Rio Piedras, Dec. 31; in stream about 5 kilometers east of Coamo, Jan. 8; in Coamo River about 5 kilometers south of Coamo Springs, Jan. 10; in Coamo River near Coamo Springs, Jan. 11; on water plants in brook west of Humacao, Jan. 21; in stream west of Humacao, Jan. 22.

C. **subtumidum** Nordst.
Lagerheim (1887). Collected at Fajardo.
On water plants in Turabo River, Caguas, Jan. 17.

C. **tinctum** Ralfs
Lagerheim (1887). Collected at Fajardo.

C. **zygomorphicum** Taft
West of Experiment Station, Rio Piedras, Dec. 31; in river, Caguas, Jan. 16; on water plants in Turabo River, Caguas, Jan. 17; in brook on way to San Lorenzo, Jan. 18.

Desmidium swartzii var. **quadrangulatum** (Ralfs) Roy
In pool near park, Santurce, Dec. 25, Feb. 8.

Euastrum attenuatum Wolle
Lagerheim (1887). Collected at Fajardo.

E. bidentatum Naeg.
On water plants in Turabo River, Caguas, Jan. 17.

E. denticulatum (Kirch.) Gay
Lagerheim (1887). Collected at Fajardo.

E. divaricatum Lund.
Lagerheim (1887). Collected at Fajardo.

E. elegans (Breb.) Kuetz.
Lagerheim (1887). Collected at Fajardo.

E. gemmatum Breb.
Lagerheim (1887). Collected at Fajardo.

E. sibiricum Boldt.
Lagerheim (1887). Collected at Fajardo.

E. subintegrum Nordst.
Lagerheim (1887). Collected at Fajardo.

E. sublobatum Breb. (*Cosmarium sublobatum* (Breb.) Arch.)
Lagerheim (1887). Collected at Fajardo.

Micrasterias sol (Ehr.) Kuetz.
On water plants in Turabo River, Caguas, Jan. 17.

Onychonema laeve var. **latum** W. & G. S. West
In stream about 5 kilometers east of Coamo, Jan. 8.

O. laeve var. **micracanthum** Nordst.
Lagerheim (1887). Collected at Fajardo.
On water plants in Turabo River, Caguas, Jan. 17.

Penium margaritaceum (Ehr.) Breb.
In stream west of Humacao, Jan. 22.

Pleurotaenium coronatum (Breb.) Rab.
In pool near park, Santurce, Dec. 25.

P. indicum (Grun.) Lund. (*P. indicum* var. *crassius* Lagerheim)
Lagerheim (1887). Collected at Fajardo.

P. maximum (Reinsch) Lund.
In pool near park, Santurce, Dec. 25; on water plants in Turabo River, Caguas, Jan. 17.

P. trabecula (Ehr.) Naeg.
On water plants in Turabo River, Caguas, Jan. 17; in brook west of Humacao, Jan. 21.

Sphaerozosma granulatum Roy & Biss. (*S. excavatum* f. *javanica* Nordst.)
Lagerheim (1887). Collected at Fajardo.
On water plants in Turabo River, Caguas, Jan. 17

Staurastrum bacillare Breb.
Lagerheim (1887). Collected at Fajardo.

S. denticulatum (Naeg.) Arch.
On water plants in Turabo River, Caguas, Jan. 17.

S. dickiei var. **circulare** Turn.
On water plants in Turabo River, Caguas, Jan. 17.

S. polymorphum Breb.
Lagerheim (1887). Collected at Fajardo.

S. rotula Nordst.
Lagerheim (1887). Collected at Fajardo.

S. trifidum var. **glabrum** Lagerheim
Lagerheim (1887). Collected at Fajardo.

REFERENCES

Britton, M. E. 1937. The freshwater algae of Puerto Rico. Master's thesis, Ohio State University.

Chodat, R. 1926. Scenedesmus. Rev. d'Hydrologie 3: 71–258.

Collins, F. S. 1909. The green algae of North America. Tufts College Series 2(3): 79–480.

1918. The green algae of North America (Second Supplement). Tufts College Series 4(7): 1–106.

Hazen, T. E. 1902. The Ulotrichaceae and Chaetophoraceae of the United States. Memoirs Torr. Bot Club 11(2): 135–250.

Lagerheim, G. 1887. Ueber einige Algen aus Cuba, Jamaica, und Puerto Rico. Bot. Notiser 1887: 193–199.

Moebius, M. 1888. Ueber einige in Portorico gesammelte Susswasser- und Luft-Algen. Hedwigia 27: 221–249.

Printz, H. 1939. Vorarbeiten zu einer Monographie der Trentepohliaceen. Nytt Mag. Naturvidenskapene 80: 10–210.

Smith, G. M. 1916. A monograph of the algal genus Scenedesmus based upon pure culture studies. Trans. Wisconsin Acad. of Sci., Arts and Letters 18: 422–531.

1920. Phytoplankton of the inland lakes of Wisconsin. Wis. Geol. and Nat. Hist. Survey. Bull. No. 57, Pt. I; 1924, *ibid.*, Pt. II.

Tiffany, L. H. 1934. Plankton algae of the west end of Lake Erie. Contrib. Stone Laboratory, Ohio State Univ., No. 6.

1936. Wille's collection of Puerto Rican freshwater algae. Brittonia 2(2): 165–175

1937. Monograph of North American Oedogoniales. North American Flora 11(1): 1–185

1937. The filamentous algae of the west end of Lake Erie. Amer. Midl. Nat. 18(6): 911–951.

West, W. and **G. S. West.** 1904–1912. A monograph of the British Desmidiaceae. Ray Soc. of London. Vol. I–IV. Vol. V by N. Carter, 1923.

Wille, N. 1915. Report on an expedition to Puerto Rico for collecting freshwater algae Jour. N. Y. Bot. Gard. 16: 133–146.

Introduction to Biophysics

Under this title the author has brought together a discussion of a number of important topics in biophysics. As the chapter headings indicate, the viewpoint is definitely slanted towards medicine and human physiology: I. Biophysically Active X-Rays. II. Applied Radioactivity. II. Biophysical Characteristics of the Eye. IV. Emission and Absorption of Biophysically Active Light. V. The Structure and Properties of Surfaces and Membranes. VI. The Biophysical Problem of Nerve Conduction. VII. Auditory Biophysics. VIII. The Compound Microscope; The Electron Microscope. The reader whose primary interest is in plant physiology, other than human, physiology, or bacteriology will turn from a reading of the book with an unsatisfied feeling, as only few applications to such branches of biology are mentioned. Within his chosen topical limits, however, the author has managed to present the current state of knowledge in this borderline domain of science with admirable concision. The section on the compound microscope should be required reading for all biologists. Perhaps the most surprising omission is the complete absence of any consideration of radiant energy from the quantum viewpoint. There are general author and subject indices, and a working bibliography at the end of each chapter.—*B. S. Meyer.*

An Introduction to Biophysics, by Otto Stuhlman, Jr. 375 pp. John Wiley & Sons, New York. 1943. $4.00.

Medical and Zoological Microtechnic

The encyclopedic method of presenting the subject has been adopted by the author. However, the book is not large, such as the German Encyclopedias of Ehrlich and Krause. The author has selected what he considers the more important technics from a voluminous literature, and presented it in a very concise form. In many instances it was not possible to include all details which might be desired. To overcome this disadvantage references are given in their appropriate places and not collected in a large bibliography. It will serve as a quick, easy reference book on a host of technics used in the study of animal tissues.—*G. W. B.*

Microscopic Technique in Biology and Medicine, by E. V. Cowdry. 206 pp. The Williams and Wilkins Company, Baltimore, Md., 1943. $4.00.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIV MARCH, 1944 No. 2

LATE MENOPAUSE AND CANCER OF THE BREAST

FRITZ BLANK, M.D.[1]
Bureau of Human Heredity, London, England, and the Department
of Zoology and Entomology, The Ohio State University

Several observers have suggested that a positive relationship may exist between the occurrence of menopause at an advanced age and the development of cancer in the tissues of the female reproductive organs. Thus Crossen and Hobbs (1) state that "the incidence of late menopause in cases of adenocarcinoma of the fundus uteri is about four times as high as it is in normal cases," while Olch (2) finds a similar relationship between a delayed menopausal age and cancer of the breast. Among his cases of 342 women suffering from breast cancer, and first coming to medical attention after the age of fifty, Olch's records showed that 187, or 54.7 per cent, were either still menstruating or had stopped after fifty. In Olch's opinion this was about five times the proportion to be expected, accepting as "normal" the figures cited in literature on the age at menopause among women in temperate climates, which in various series appears to be fifty years or more in only nine to twelve per cent, or an average of eleven per cent of all the cases.

Many experiments with animals have established the fact of hormonal (estrogen) action in the production of mammary tumors and certain tumors of the body of the uterus. (3) (4) Thus it is quite conceivable that the prolonged hormonal stimulation incident to delayed menopause may be related to the development of malignancies in genital tissues. However, the question whether a delayed menopause actually coincides with an increased incidence of cancer of the breast and the corpus uteri is not only of theoretical interest in the study of tumor genesis, but is of great practical importance. For at least in connection with breast cancer it has already been recommended that "a prophylactic artificial menopause should be proposed to those women menstruating beyond any arbitrary age that we may choose, forty-eight or fifty, whether or not those women have palpable breast changes." (2)

The next question is whether the evidence for a direct relationship between late menopause and the development of malignancies in breast or uterus is statistically so conclusive that such a procedure is warranted Crossen and Hobbs (1) have rightly warned against "certain pitfalls in gathering statistics on normal menopause which have not been taken into account in the compilation of statistics in the present day literature." One such pitfall lies in the use of antiquated data to arrive at a so-called "normal" menopausal age. For it is the impression of many experienced physicians and statisticians that during the last few decades the menstrual cycle has changed its range considerably in many countries, so that figures gathered fifty or seventy years ago cannot be accepted as a basis for judging conditions today.

But from still another viewpoint the conclusion drawn from Olch's material does not seem to be quite valid, at least as to specific estrogenic action on cancer of the breast, in the absence of comparative data on the incidence of cancer of other sites collected from a similar population. The writer has therefore attempted to secure further evidence on this problem by comparing the conditions found in a series of cases of breast cancer with those in a series of cases of cancer in tissues not usually assumed to be under ovarian influence, such as the skin, the lips, the tongue, and the gastrointestinal tract The investigation was confined to mammary cancer because of the comparatively rare incidence of carcinoma of the body of the uterus. Further it appeared desirable to compare the distribution of menopausal age among cancer patients with that among women in a general hospital, suffering from various non-cancerous conditions, whether under surgical or general medical care.

---

[1] Dr. Blank's present address is 5 E. 76th St., New York.

The three series of cases were drawn from medical records in the Columbus Cancer Clinic, and the Ohio State University Hospital, and may be presumed to be largely homogeneous, from the environmental point of view. The author is deeply indebted to the officers of these two institutions for their courtesy and co-operation in this investigation as well as to Dr. Earl L. Green, of the Ohio State University, for his statistical advice.

METHOD AND PROCEDURE

In drawing the cases from the files of clinic and hospital, the common principle of selection was that the patient should have been admitted when at least fifty; that information was available as to the age at menopause (i. e., the final cessation of the menstrual flow); and that there was no history of previous pelvic operation. Otherwise these were random samples compiled from the records of 1921–1941.

TABLE I

AGE AT MENOPAUSE REPORTED BY THREE GROUPS OF PATIENTS WITH (I) CANCER OF BREAST, (II) CANCER OF NON-GENITAL TISSUES, AND (III) CONDITIONS OTHER THAN CANCER.
(Columbus, Ohio, 1941)

REPORTED AGE AT MENOPAUSE	SAMPLE I Breast Cancer		SAMPLE II Non-genital Cancer		SAMPLE III Other than Cancer	
	No.	%	No.	%	No.	%
Under 40	3	2.0	4	2.4	3	5.0
40–44	21	14.3	28	17.2	7	12.0
45–49	39	26.6	56	34.4	21	35.0
50 and over	84	57.1	75	46.0	29	48.0
Total	147	100.0	163	100.0	60	100.0

The two series from the Cancer Clinic included, in Sample I, 147 cases of cancer of the breast; and in Sample II, 163 cases of cancer of other sites, mainly "external" and all strictly non-genital and non-mammary. Sample II was made up of 128 cases of cancer of the skin, lip, and oral cavity, together with 35 cases of cancer of the gastrointestinal tract and accessory bodies such as the gall-bladder.

The age at menopause for the two groups of women is shown in Table I. From this it will be seen that the proportion of women reaching the menopause when younger than forty is about the same for the two groups, although it is a fraction larger in the group with non-genital cancer; while the proportion reaching the menopause between forty and forty-four is three points higher in the non-genital group; and between forty-five and forty-nine the non-genital group is eight points higher.

But the group with breast cancer reported menopause at fifty or over in 57 per cent of the cases, as compared with 46 per cent among the non-genital cancer group.

The figure of 57 per cent in our series of cases with breast cancer compared well with the 55 per cent cited by Olch in his series of 342 cases; and the apparently high coincidence of late menopause with cancer of the breast seemed to confirm his conclusion of a causative relationship. But later critical examination makes it appear that these figures can be accepted as establishing prolonged estrogenic action as a causative agent in the development of mammary cancer *only* if the distribution of menopausal age can be shown to be strikingly different among cases of cancer of tissues which are not usually assumed to be influenced by estrogenic action However, as shown in Table I, among the 163 women suffering from cancer of the skin, lip, oral cavity or gastrointestinal tract, 75, or 46 per cent, likewise reached the menopause after fifty If the 35 cases of gastrointestinal cancer are excluded, the others with purely "external" cancer show 47 per cent menstruating after fifty But this is a figure at least four times as high as would be expected if we assume with Olch that only about eleven per cent of women are normally in this group.

Two explanations for this surprising fact suggest themselves First, if the figure of eleven per cent—or about one in nine—is considered as a normal incidence of late menopause, the inference is that cancer of other tissues beside the genital are likewise related to a prolongation of estrogenic activity Such a possibility cannot be disregarded in the light of discoveries in animal experimentation Leo Loeb (3) has pointed out that in animals, carcinogenic action of the estrogens is not necessarily *specific* for the development of mammary cancer; and he and other observers have found sarcoma developed after prolonged estrogenic treatment, sometimes in regions remote from the site of the injections Lacassagne (7, 8) e. g., has found sarcomas in the bladder and in the thymus after prolonged estrogen treatment. (See references for the more important of these findings by Leo Loeb (3); C. F. Cori (5); W. U. Gardner, G. M Smith, L. C Strong and E. Allen (6); A. Lacassagne (7) (8); and E. L. Burns, V. Suntzeff, and L. Loeb (9))

It is possible therefore that prolonged estrogenic action might have been effective in the production of a high incidence of cancer of various non-genital tissues in our series of women

However, another explanation is possible, and that is that the percentage of women who "normally" reach the menopause when fifty or older, is greater than might be assumed from figures cited in the earlier literature, so that the women with cancer of various tissues who also reach the menopause at an advanced age simply represent the common condition. If there is on the contrary a positive correlation between late menopausal age and cancer of the breast and other tissues, one is bound to find statistically significant differences in the distribution of this age among cancerous and non-cancerous cases in the same population at the same period.

To follow this lead, a third series of cases was gathered, this time from the Ohio State University Hospital, and makes up Sample III, a group of women suffering from various surgical and general conditions, all definitely non-cancerous, such as fractures, gastric ulcers, cholecystitis, arthritis, and metabolic disturbances. All cases with previous pelvic operations were excluded; and all in which there was evidence of some pelvic or endocrine condition which might have influenced the onset of menopause; and of course cases with a history indicating possible malignancy at any time were ruled out. Since the age at menopause is not recorded routinely in a general hospital, the range of choice was further limited Finally after the examination of many hundreds of records, sixty cases were found which met all the specifications. To possible criticisms of the small size of this sample the answer is offered that a relatively few cases gathered as nearly as can be under identical conditions offers a better basis for statistical comparison than a large number collected from a wide variety of sources in the literature of different countries and times, and representing completely disparate environmental conditions.

Subdivided according to the age at menopause, Sample III also appears in Table I. Comparing this distribution with that in Sample II, the non-genital cancer cases, one is struck by their close similarity in the groups reaching menopause at forty-five or forty-nine and after fifty.

By comparing the three samples it is clear that the breast cancer cases do not differ markedly from the other groups, although there is a lower incidence of menopause at ages younger than fifty and a considerably higher incidence of menopause at fifty or more. But, as the table clearly shows, these differences in the incidence of a late menopause in the cases of breast cancer and in the series of non-genital cancer and non-cancerous cases are not great enough to warrant conclusions as to a causative relationship between delayed menopausal age and cancer of the breast.

When a statistical comparison is made of the two percentages of women with menopause after 50, with and without breast cancer, it is found that the difference (11.1 = 57.1—46.0) is almost exactly 1.96 times its own standard error, and therefore has a 5 in 100 chance of being due to sampling fluctuation alone. Statistically therefore it cannot be interpreted either definitely in the positive or definitely in the negative. In any case, the conclusions which can be drawn from the figures given do not sufficiently support the above mentioned statements as to a true association between a late menopausal age and cancer of the breast.

For this reason it would appear that the proposal to induce an artificial menopause in cases with a delayed menopause in order to prevent mammary cancer has not as yet on a secure statistical basis.

GENERAL DISCUSSION

From a practical point of view the conclusions which may be drawn from our data are unsatisfactory, since they demonstrate only the fact that we are far from an answer to the question of the relation between late menopausal age and cancer of the breast. The author's findings in this investigation are in complete agreement with those arrived at by E. K. Dawson (10) who in his paper, "The Menopausal Age and Mammary Cancer" was able to say only that "the figures representing the age distribution of the menopause and the incidence of cancer of the breast are not *inconsistent* with the hypothesis, suggested by other considerations, that a correlation exists."

In fact, one may admit that the hypothesis of such a correlation suggests itself also from the author's present data, with the high coincidence of breast cancer and late menopausal age, 57 per cent as compared with 46 or 48 per cent in the non-genital cancerous and the non-cancerous groups, even if the difference reaches only the borderline of statistical significance. But much more work must be done before one can arrive at a safe basis for judgment.

One of the main hindrances to the solution of the problem is ignorance of the actual facts with regard to the normal age distribution at menopause. Existing statistics are for the most part antiquated, as for example the frequently cited figures of Kisch which were published in 1874 (11), those of Currier (12) (1897) and of Krieger (13) (1869); or when later figures are used, they may be drawn from scattered or inadequate sources; and insufficient account is taken of the completely different environmental conditions existing among the women in the various groups which may be under consideration, so that the figures may not be truly comparable for statistical purposes.

Other pitfalls are inherent in the method of collection and evaluation of the desired data. For example, the writer collected his age data by single years, but for this particular investigation presented them in the same classification as Olch, by five-year groups—40–44, 45–49, 50 and over—so that the results might be compared. This arrangement however is not satisfactory for statistical purposes, because of the peaks naturally occurring at the years forty, forty-five and fifty. For women are inclined to give the age at menopause in round figures, especially if several years have passed. The characteristic peak at the fiftieth year is shown very clearly in Dawson's tables (11). In his series of 244 "normal" surgical cases, the figures go as follows:

46 cases at 47 years
24 " " 48 "
24 " " 48 "
23 " " 49 "

then jump to

52 cases at 50 years

and fall again to

10 cases at 51 years
10 " " 52 "
8 " " 53 " and so on.

The author has found the same inexact memory about the age at menopause in many cases under observation; these artificial peaks at the five year or ten year intervals are familiar to all students of population statistics, making a major source of error in interpretation. But this fact is bound to have an especially important bearing on our problem, since it is precisely the year fifty which is considered the point marking a delayed or non-delayed menopause Therefore, it is evident that the conclusions to be drawn from such investigations may depend more or less upon the way in which the year "fifty" is dealt with, i e., whether the age groups are subdivided, e. g, in those from 40 to 44, 45 to 49, 50 and over; or whether the same material is subdivided into the groups 41 to 45, 46 to 50, 51 and over, as some authors prefer Only the most carefully collected material, by single years, checked and verified wherever possible by clinical inquiry, can serve our need for exact data with regard to the relation between delayed menopause and cancer.

Aside from purely statistical considerations it seems highly desirable to elucidate the whole biological question of the possible role of prolonged estrogenic activity in the development of cancer in the female genital tissues This requires the consideration of the length of the entire menstrual cycle, so that the age at onset of menstruation should be registered as well as the age at its cessation.

It is a striking and apparently well-established fact that, at least in our temperate climate, menopause at a late age usually occurs in women who started to menstruate at an early age; the reverse condition also being true, that the later the onset the earlier the cessation, as described by E. Novak (14) (15). Individual women will therefore differ considerably in their experience of estrogenic activity, and it may be assumed that these differences in the length of the menstrual cycle have an important bearing on our problem. Thus a woman starting to menstruate at the age of twelve and stopping at fifty-four, with a consequent cycle of forty-two years, may naturally show a quite different biological reaction of the tissues to estrogenic activity from that of the woman starting at sixteen and ending at forty-eight or earlier, with a cycle of estrogenic activity of thirty-two years or less.

Hereditary factors enter into the question of the differences in the range of the menstrual cycle, a phase which has been of interest to the writer for a number of years. E. Petri (16), by means of careful investigation into the records of identical and non-identical twins and of sisters in large families, has already accumulated much evidence for the determination by genetical factors of at least the onset of the cycle. It is still an open question as to how much hereditary factors, in inter-action with environmental factors, are operative in the varying ranges of the menstrual cycle.

A far more extensive body of material is needed on the actual experience of women with regard to the menstrual cycle than has yet been available and an investigation is now under way which may lead to some understanding of the fact that "breast cancer runs in certain families."

REFERENCES

(1) **Crossen, R. J., and J. E. Hobbs.** Relationship of Late Menstruation to Carcinoma of the Corpus Uteri. J. Missouri M. A., 1935. 32: 361–363.

(2) **Olch, Isaac Y.** The Menopausal Age in Women with Cancer of the Breast. Am. J. Cancer, 1937. 31: 563–566.

(3) **Loeb, Leo.** The Significance of Hormones in the Origin of Cancer. Journal of the National Cancer Institute, 1940–41. 1: 169–195. (Bibliography of 151 references.)

(4) **Suntzeff, V., E. L. Burns, Marian Moskop and Leo Loeb.** The Effect of Injections of Estrin on the Incidence of Mammary Cancer in Various Strains of Mice. Am. J. Cancer, 1936. 27: 229–245.

(5) **Cori, C. F.** Influence of Ovariectomy on the Spontaneous Occurrence of Mammary Carcinomas in Mice. J. Exper. Med., 1927. 45: 983–991.

(6) **Gardner, W. U., G. M. Smith, L. C. Strong and E. Allen.** Development of Sarcoma in Male Mice Receiving Estrogenic Hormones. Arch. Path. 1936. 21: 504–508.

(7) **Lacassagne, A.** Sarcomes fusocellulaires apparus chez des souris longuement traitées par des hormones oestrogénes. Compt. rend. Soc. de Biol., 1937. 126: 190–192.

(8) **Lacassagne, A.** Sarcomes lymphoides apparus chez des souris longuement traitées par des hormones oestrogénes. Compt. rend. Soc. de Biol., 1937. 126: 193–195.

(9) **Burns, E. L., V. Suntzeff and Leo Loeb.** The Development of Sarcoma in Mice Injected with Hormones or Hormone-Like Substances. Am. J. Cancer, 1938. 32: 534–548.

(10) **Dawson, E. K.** Menopausal Age and Mammary Cancer. Lancet, 1932. 1: 1251–53.

(11) **Kisch.** Das Klimakterische Alter der Frauen in physiologischer und pathologischer Beziehung. Erlangen, 1874.

(12) **Currier, A. F.** The Menopause. New York, 1897. D. Appleton Co.

(13) **Krieger, E.** Die Menstruation. Berlin, A. Hirschwald, 1869.

(14) **Novak, E.** Menstruation and its Disorders. New York and London, J. Appleton & Co., 1931.

(15) **Novak, E.** The Menopause (Climacterium, "Change of Life"). In Obstetrics and Gynecology, ed. by A. H. Curtis, 1933. 1: 298–305.

(16) **Petri, E.** Untersuchungen zur Erbbedingtheit der Menarche. Zeitschr. f. Morphol. und Anthropol., 1934. 33: 43–48.

Gustatory Experimentation

It is a case of circumstance where professors who appreciate the amenities also learn to face somewhat rigorous temporary conditions at field stations. Two such, Professor Fernald of Harvard and Professor Kinsey of Indiana University, have met the tests at both extremes and put their talents together to produce a book on edible wild plants that is a gem of its type. Since it is in part a botanical manual and in part a cook book with recipes, the merit of the book lines in its quality rather than in its novelty. The statement that a lack of knowledge of calories at the time the manuscript was begun caught this reviewer's eye, and a letter to Professor Kinsey brought the prompt and courteous reply that the work was begun twenty-five years ago. "Both Professor Fernald and I," the letter goes on to say, "have done a great deal of camping and had learned independently something of the use of our wild plants." And it should be added that the experiences of a quarter of a century of camping and trying out new foods make even seed catalogs tame in comparison. The reader is shown identifying traits of poisonous plants. There are line drawings, references to a wide range of literature and a general atmosphere of enthusiasm that makes good reading.—*A. E. Waller.*

Edible Wild Plants of Eastern North America, by Merritt Lyndon Fernald and Alfred C. Kinsey. 452 pp., line drawings, photographs, bibliography, index. Idlewild Press, Cornwell-on-Hudson, N. Y., 1943. $3.00.

NOTES ON MEXICAN AND CENTRAL AMERICAN PSYLLIDAE (HOMOPTERA)

JOHN S. CALDWELL,
Circleville, Ohio

All species in this report, unless noted otherwise, were taken by Dr. D. M. DeLong, Dr. C. C. Plummer, Mr. Gene Good, and the writer the fall of 1941. Deposition of type material is in the writer's collection.

Livia mexicana n. sp.

(Fig. 1)

Length to tip of forewing 3.1 mm., forewing 2.3 mm.

General color orange-brown over all, entire venter and tips of antennae black.

Vertex one and a half times as long as broad, not deeply notched cephalad; eyes flattened. Forewings twice as long as broad, ovate, rugose, translucent. Forceps of male almost as long as proctiger, caudal margins evenly lunate, apices diagonally truncate, cephalic margins suddenly expanded basally at midlength.

This species somewhat resembles *vernalis* Fitch but is smaller with a more shallow notched vertex and distinct genitalia.

Male holotype near Orizaba, near Vera Cruz, October 17, 1941, from sedge and grass in an oak-pine association.

Aphalara simila Cald.

Two specimens from Uruapan, Michoacan, October 1, 1941, from roadside weeds.

Heteropsylla texana Crawford

A few specimens from Tehuacan, Puebla, October 17, 1941, and very common at Tehuantepec, Oaxaca, October 13, 1941, on "Huasache."

Heteropsylla mexicana Crawford

Specimens taken from semi-desert vegetation between Jacala and Zimapan, Hidalgo, and near Zamora, Michoacan.

Heteropsylla forcipata Crawford

(Figs. 2 and 2A)

One male specimen recognized from Tehuantepec, Oaxaca, October 13, 1941, taken along with many specimens of *mexicana* Crawf. The genitalia of this specimen is not exactly as Crawford[1] has illustrated, but it is structurally the same, the difference in appearance probably being due to treatment with caustic.

Heteropsylla huasachae Cald.

This species was very abundant at Tehuantepec, Oaxaca, on "Huasache." Dr. Plummer also took this species at Popaya, in Guatemala, March 9, 1942.

Heteropsylla didubiata n. sp.

(Fig. 3)

Length to tip of forewing 2.6 mm., forewing 2.2 mm.

General color light yellow green over all.

Head as broad as thorax; genae greatly swollen; clypeus very prominent. Thorax strongly

---

[1] 1914. Crawford, D. L. U. S. N. M. Bull. 85, pl. 8, figs. 116–118.

arched, robust. Forewings almost two and a half times as long as broad; pterostigma very broad and long. Female genital segment as long as rest of abdomen; dorsal valve abruptly styliform in apical half; ventral valve almost as long as dorsal, acute apically.

Female holotype and paratype from Tamazunchale, San Luis Potosi, November 15, 1938 (Caldwell).[3]

This may be the female of *forcipata* Crawford but the writer believes not because this species is much larger than the specimens of *mexicana* or *forcipata* and the color is definitely green and not brown or black as in those species; furthermore this species was taken while sweeping lush tropical vegetation while the former mentioned species were found on plants in a semi-desert habitat.

Caraidara dugesii Loew

One female from Carapan, Michoacan, October 2, 1941, Km. 432, and numerous specimens of both sexes from Popaya in Guatemala, Km. 99, March 9, 1942, by Dr. Plummer.

Rhinopsylla nigra Laing

(Fig. 17)

1923. *Rhinopsylla nigra* Laing, Ann. & Mag. Nat. Hist. (9) 11: 697.

This collection contains thirty specimens from Tuxpan, Carapan, Uraupan, and Zitacurao, Michiocan, Orizaba, Veracruz, and Puebla, Puebla. The female exhibits the sexual dimorphism typical of the Rhinopsylla. Though the ground color is black, the vertex, pronotum, and praescutum are pink to light tan and the scutum has four light stripes. The female is a good deal larger than the male, measuring 3.4 mm. to tip of forewing, with a forewing of 2.9 mm. The ventral valve of the genital segment is scarcely shaped, appearing just like a last ventral segment.

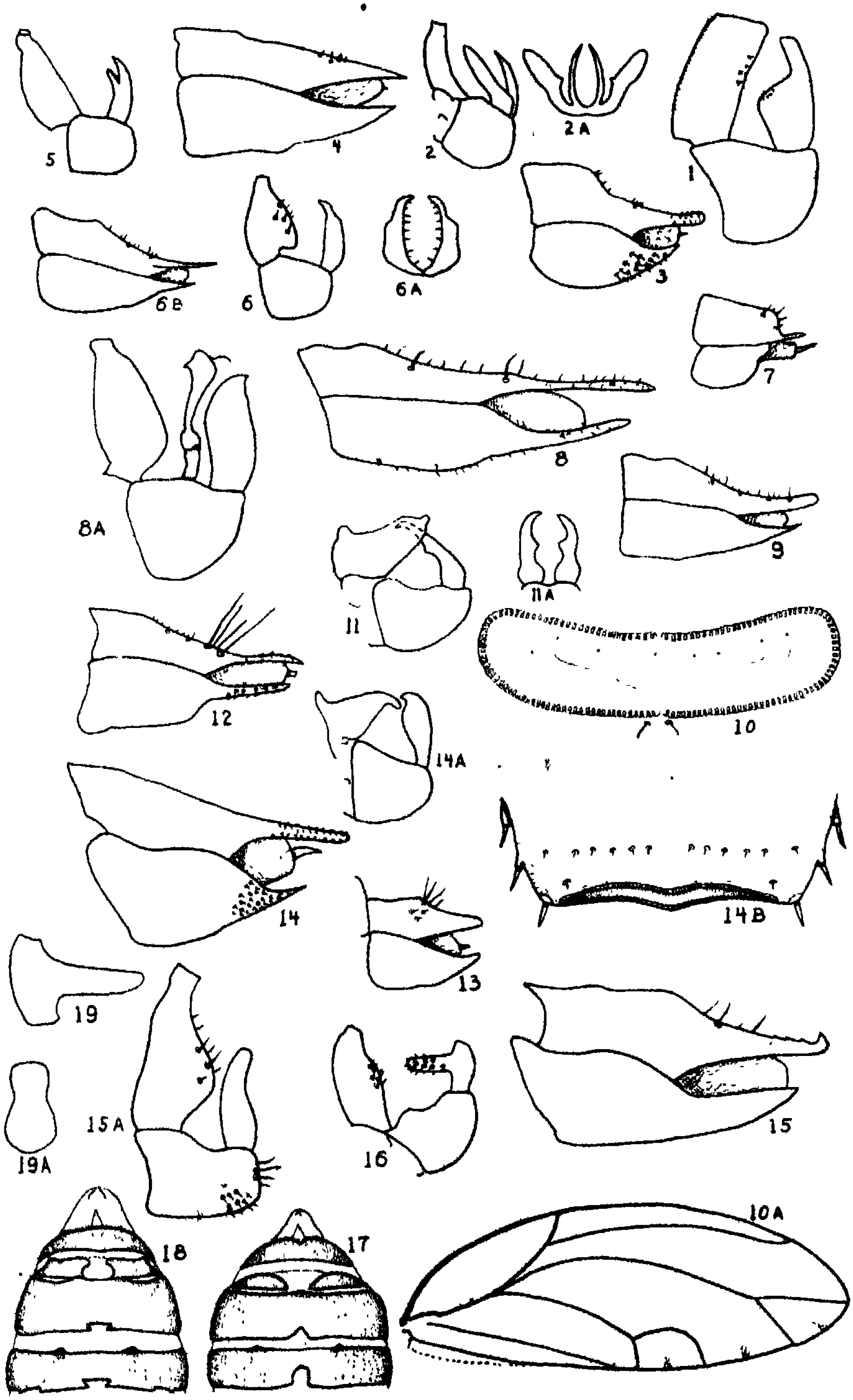
Holotype female from Orizaba, Veracruz, October 5, 1941, paratypes from the above mentioned localities. This species is closely related to *rubrafacia* Caldwell. (Fig. 18.)

---

[3] 1941. Caldwell, J. S., Ohio Jr. Sci. 41: 420. (Under *H. forcipata*.)

EXPLANATION OF PLATE I

1. *Livia mexicana*. Profile of male genitalia.
2. *Heteropsylla forcipata* Crawf. Profile of male genitalia.
2. A. Caudal view of male forceps.
3. *Heteropsylla didubiata*. Profile of female genitalia.
4. *Paratrioza plummeri*. Profile of female genitalia.
5. *Trioza rugosata*. Profile of male genitalia.
6. *Trioza stroma*. Profile of male genitalia.
6 A. Caudal view of male forceps.
6 B Profile of female genitalia.
7. *Trioza zogoda*. Profile of female genitalia.
8. *Trioza apartata*. Profile of female genitalia.
8 A. Profile of male genitalia.
9. *Trioza hidalgoensis*. Profile of female genitalia.
10. *Trioza epiphilata*. Circum-anal ring of immature.
10 A. Forewing of adult.
11. *Trioza albanigra*. Profile of male genitalia.
11 A. Caudal view of male forceps.
12. *Trioza rugosata*. Profile of female genitalia.
13. *Arytaina virgina*. Profile of female genitalia.
14. *Mitrapsylla deserata*. Profile of female genitalia.
14 A. Profile of male genitalia.
14 B. Abdominal apex of immature.
15. *Caradocia delongi*. Profile of female genitalia.
15 A. Profile of male genitalia.
16. *Psylla minutiforma*. Profile of male genitalia.
17. *Rhinopsylla nigra* Laing. Sclerite formation on ventral side of female abdomen.
18. *Rhinopsylla rubrafacia* Cald. Sclerite formation on ventral side of female abdomen.
19. *Paratrioza simila*. Profile of male proctiger.
19 A. Circum-anal ring of female.


2A
6B
6A
8A

Paratrioza plummeri n. sp.

(Fig. 4)

Length to tip of forewing 3.5 mm., forewing 3.1 mm.

General color light brown with legs and venter of abdomen yellow.

Vertex twice as broad as long, foveal impressions elongate, deep. Genae swollen subspherically; antennae over one and a half times as long as width of head; clypeus small. Pronotum small, greatly depressed; praescutum as broad as long. Vertex and thorax finely pubescent. Forewings over three times as long as broad, acute apically; humeral angles darkened; radial sector very long. Hind tibiae with apical spur ratio of 2–1. Female genital segment as long as rest of abdomen, both valves gradually acute apically.

Female holotype and paratype from Tehuacan, Puebla, October 17, 1941.

The writer names this species in honor of Dr. Charles C. Plummer.

Paratrioza simila n. sp.

(Figs. 19 and 19A)

Length, male 3.4 mm., female 3.8 mm.; forewing, male 2.8 mm., female 3. mm.

Color and markings of male identical to *cockerelli* Sulc except concentric macula in center of vertex is much more prominent and the thorax is possibly less black with more red background. Female predominently red-orange with a black spot in either half of the vertex and a few black dashes laterally on either side of the notum. Both sexes have the abdomen black above and the forewings yellowish.

Vertex not especially emarginate. Genal cones short, blunt, divergent. Clypeus large. Antennae one and a half times as long as width of head. Pronotum greatly depressed. Forewings three times as long as broad, acute apically. Proctiger of male with very long, slender, lateral flaps, much longer than in *cockerelli*. Forceps long, slender, siculate apically. Dorsal valve of female genital segment short, blunt; anal opening shape of an "hourglass." Ventral valve one-third as long as dorsal, not acute apically.

Male holotype, female allotype, and paratypes of both sexes from San Cristabol in Guatemala, March 30, 1943 (Plummer). Two male and two female paratypes from Carapan, Michoacan, October 4, 1941, and two male and one female paratypes from Rio Frio, Puebla, October 7, 1941.

Where this species and *cockerelli* Sulc. occur together *simila* may be easily recognized by its larger size.

Paratrioza cockerelli Sulc.

Taken as far south as Km. 55, Rio Frio, Puebla, October 7, 1941. The Rio Frio specimen was taken from fir and pine at an elevation of about 10,000 ft. along with specimens of *simila*.

Trioza rugosata n. sp.

(Figs. 5 and 12)

Length to tip of forewing, male 2.9 mm., female 3.4 mm.; forewing, male 2.5 mm., female 2.6 mm.

General color dark brown; genal cones, antennae, and legs light brown.

Vertex about one and a half times as broad as long, swollen on either side of median line. Genal cones as long as vertex, slender, acute. Antennae scarcely longer than width of head. Vertex and thorax finely and evenly pitted. Forewings over twice as long as broad, not acute. Metacoxae with caudal spurs. Hind tibiae with apical spur ratio of 3–1. Forceps of male with deeply bifed apices projecting cephalad. Female genital segment shorter than rest of abdomen; both valves abruptly stylate in caudal half.

Male holotype from Zimapan, Hidalgo, September 26, 1941; female allotype from Carapan, Michoacan, October 2, 1941.

Trioza thoracia Cald.

One male of this unique humpbacked species from Puebla, Puebla, October 18, 1941, on an unidentified roadside weed.

Trioza stroma n. sp.

(Figs. 6 and 6A)

Length to tip of forewing, male 2.8 mm., female 3. mm.; forewing, male 2.4 mm., female 2.5 mm.

General color yellow with apical half of antennae and dorsum of thorax black; apical angles of forewings yellowish.

Vertex only one-fourth broader than long. Genal cones as long as vertex, slender, acute. Antennae one and a half times as long as width of head. Head about as broad as thorax. Thorax short. Forewings almost three times as long as broad, rather broadly rounded; cubital and medial cells small. Hind tibiae with apical spur ratio of 3–1. Forceps of male short, stout, acute apically. Dorsal valve of female with extremely fine styliform apex for apical fourth.

Female holotype, male allotype, five male and five female paratypes from Cuernavaca, Morelos, Km. 57, October 21, 1941.

This species resembles *chlora* Tuthill and *nicaraguensis* Crawford.

Trioza zogoda n. sp.

(Fig. 7)

Length to tip of forewing 3. mm.; forewing 2.5 mm.

General color brown with head and legs yellow.

Vertex almost as long as broad, almost vertical. Genal cones three-fourths as long as vertex, acute, divergent. Head almost as broad as thorax. Thorax rather flat; prothoracic dorsum suddenly depressed, vertical. Forewings rather broadly rounded. Hind tibiae with apical spur ratio of 3–1. Female genital segment with both valves appearing short, chubby; dorsal valve with needle-like apex.

Female holotype from Orizaba-Puebla road, Km. 277, October 17, 1941.

Trioza apartata n. sp.

(Figs. 8 and 8A)

Length to tip of forewing, male 4.2 mm., female 5. mm.; forewing, male 3.5 mm., female 4.1 mm.

General color brown; antennal joints, apical tarsi, abdomen, genital segment, and basal angles of forewings blackish.

Vertex one and a fourth times as broad as long; foveal impressions very deep, broad, making lateral and basal margins of vertex appear raised and ridged. Genal cones as long as vertex, appressed for full length. Antennae twice as long as width of head. Pronotum depressed almost vertical; mesoscutum as long as broad, rather acute cephalad. Forewings almost three times as long as broad, broadly rounded apically. Metacoxae with caudal spurs. Hind tibiae with apical spur ratio of 3–1. Female genital segment as long as rest of abdomen, narrow, styliform for full length. Forceps of male stout, bearing short chubby spurs at apex.

Female holotype and seven paratypes from Zimapan, Hidalgo, September 26, 1941, one paratype from Jacala, Hidalgo, September 26, 1941, and one from Orizaba, Veracruz October 17, 1941; male allotype and four paratypes from Jacala, and one from Zimapan, Hidalgo, September 26, 1941.

Trioza hidalgoensis n. sp.

(Fig. 9)

Length to tip of forewing 3.5 mm.; forewing 2.8 mm.

General color black with entire praescutum and a broad stripe on scutum red; margins and center of vertex orange, making a black U on the vertex.

Vertex twice as broad as long. Eyes prominent. Genal cones three-fourths as long as vertex, acute. Antennae one and a fourth times as long as width of head. Head as broad as thorax. Forewings little over twice as long as broad, rounded apically.

Metacoxae with caudal spurs. Hind tibiae with apical spur ratio of 3–1. Female genital segment not quite as long as rest of abdomen; dorsal valve styliform, elevated in apical third.

Holotype and paratype female from Zimapan, Hidalgo, September 26, 1941, on Moctezuma pine. This species is related to the *frontalis* Crawford group.

Trioza epiphitatae n. sp.

(Fig. 10)

Length to tip of forewing 2.4 mm., forewing 2. mm.

General color green-yellow over all.

Vertex almost twice as broad as long; foveae deep, broad. Genal cones as long as vertex, divergent. Antennae one and a half times as long as width of head. Forewings two and a half times as long as broad, acute apically; membrane somewhat rugose; cubitus separating from main stem a little before radius and medius. Metacoxae with very small caudal spurs. Hind tibiae with apical spur ratio of 3–1. Male forceps short, stout, ending apically in prominent spines.

Male holotype near Morelia, Michoacan, October 4, 1941, on an epiphite. This plant seemed to be scattered from the mountains just south of Monterrey, N. L., to Tamazunchale, S L. P., and west of Mexico City from Morelia, Mich., to the state of Jalisco.

Whereas the forewing of this species is strictly neither Triozinae nor Cerophyllinae, the sectasetae on the immature are elongate like those on the Triozinae, therefore this species is placed in *Trioza*.

Trioza arizonae Aulmann

Specimens were taken from Orizaba, Veracruz, and Zamora, Michiocan, on different species of willow. Dr. Tuthill has suggested to the writer that this species may be nothing more than a color variety of *minuta* Crawford. The immatures of this species and those of the dark form of *minuta* seem to differ only in size and segmentation of the antennae. One specimen collected by Dr. Plummer at San Miguel in El Salvador, March 19, 1942, has a very narrow and elongate cubital cell in the forewing and may not be specific with the Mexican forms.

Trioza mexicana Crawford

Numerous specimens were taken at Mt. "El Popocataptl," September 28, 1941, at 11,500 ft. elevation. This species seems to be confined to the higher altitudes.

Trioza albanigra n. sp

(Fig. 11)

Length to tip of forewing 3.1 mm., forewing 2.7 mm.

General color shining black except extremities of legs and segments III-IV-V of antennae white.

Vertex with broad shallow foveae. Genal cones half as long as vertex, acute, divergent. Antennae less than twice as long as width of head. Praescutum acute cephalad. Forewings almost two and a half times as long as broad, acute apically, yellowish. Hind tibiae with apical spur ratio of 2–1. Forceps of male strongly curved cephalad, acute apically, with a blunt spur located at midlength on inner margin.

Holotype male from Mt. "El Popocataptl," September 28, 1941, 10,800 ft. Paratype from Rio Frio, Puebla, October 22, 1941, 10,000 ft.

Trioza albanigra var. **aurodorsa** n. var.

Structurally similar to *albanigra albanigra*. Gold to orange over all except for black eyes and two black lines on scutum. Females with dorsal valve almost as broad as long; anal opening shape of "hourglass." Ventral valve broader than long in ventral aspect, not acute apically.

Male holotype, female allotype, and two paratypes from Rio Frio, Puebla, October 22, 1941, 10,000 ft.

Trioza koebelei Kirkaldy

Galls formed by the immature stages of this species were seen at Uruapan, Michoacan, and Cordoba, Veracruz. This species has been recorded from the State of Morelos by G. R. Valencia,[3] the State of Queretaro by D. S. Ibarra,[4] and the State of Tamaulipas by N. Stahler.[5]

---

[3] 1912. Valencia, Gabriel Ruiz. "Cultivo y Explotacion del Aguacate." Boletin numero 71 de la Estacion Agricola Central., pp. 50–51, (three plates).

[4] 1929: Ibarre, David S. "El Aguacate" Secretaria de Agr. y Formento.

[5] 1941. Stahler, N. Calif. Dept. Agr. Bull. No. 2, 39: 217.

Pachypsylla tropicala n. sp.

Length to tip of forewing 3. mm., forewing 2.6 mm.

General color black, vertex brownish. Forewing very clear, glass-like; a broken subapical black band present; apex brokenly maculate; pterostigma a black spot; black spot present on sutural margin half distance to claval apex; and a slightly darkened area present across cubital petiole.

Vertex twice as broad as long, roughened. Genal cones very short, twice as broad as long. Thorax not especially arched; covered with dense, short, white pubescence. Forewings over two and a half times as long as broad, ovate; pterostigma short, small. Forceps of male narrow, short.

Male holotype from Tepotzlan, Morelos, (collector and date unknown).

Arytaina virgina n. sp.

(Fig. 13)

Length to tip of forewing 2.4 mm., forewing 1.9 mm.

General color orange over all with indications of white stripes on thoracic dorsum, white spots around ocelli, and genal cones white with black tips.

Vertex twice as broad as long, very deep foveae on either side of median line. Genal cones very short, rounded. Head almost vertical with thorax strongly descending. Forewings two and a half times as long as broad; pterostigma very broad, long; cubital cell twice as large as medial. Female genital segment little over half as long as rest of abdomen; dorsal valve slender with apical third styliform; ventral valve thick, heavy.

Female holotype and two paratypes, Puebla, Puebla, October 18, 1941.

Mitrapsylla albalineata Crawford

This species was taken at Tehuacan, Puebla, October 17, 1941, on a shrub belonging to the Fabaceae. The specimens fit the variation that Crawford described from Oaxaca except that the female genitalia is not deflexed.

Mitrapsylla deserata n. sp.

(Figs. 14, 14A, and 14B.)

Length to tip of forewing, male, 2.2 mm , female 2.9 mm.; forewing, male 1.8 mm., female, 2.3 mm.

General color deep orange with a prominent median line for full length of thoracic dorsum white to yellow. Raised ridges on vertex light. Eyes, apices of antennae, and four marginal spots on forewings black.

Vertex almost twice as broad as long, central ridges very prominent. Genal cones very short, blunt. Antennae as long as entire insect. Head almost as broad as thorax. Forewings twice as long as broad; pterostigma very short; Cu_2 highly arched. Forceps of male with apical hooks projecting cephalad. Proctiger with long caudal flaps. Female genital segment as long as rest of abdomen; dorsal valve straight, flat dorsad; ventral valve acute, styliform in apical third.

Male holotype, female allotype, and many male and female paratypes from Tehuantepec, Oaxaca, October 13, 1941; one male paratype from Jesus Carranza, Veracruz, October 14, 1941; and two female paratypes from Iguala, Guerrero, October 25, 1941.

The immatures resemble those of psylla, especially the group with the anal opening located on the apex of the abdomen. The circum-anal ring appears to be a single ring of slit-like pores. The host plant is "Hausache."

Caradocia delongi n. sp.

(Figs. 15 and 15A.)

Length to tip of forewing, male 4.2 mm., female 5. mm.; forewing, male, 3.7 mm., female 4. mm.

General color bright blue-green with large golden spots on center of mesoscutum and laterally on metascutum; antennae beyond third segment black.

Vertex over twice as broad as long, pubescent, somewhat rolled roundedly forward. Caudal ocelli raised. Eyes stalked; postocular area large. . Genae fused into vertex, separated basally and contiguous apically; apices slender, acute. Antennae longer than entire insect Thorax robust, arched. Forewings over twice longer than broad; costal margin greatly curved; medial and cubital cells very elongate. Forceps of male of even width throughout, curved cephalad. Proctiger with caudal flaps. Female genital segment as long as rest of abdomen; dorsal valve styliform in apical third, minutely serrate dorsad; ventral valve of equal length as dorsal, of heavy build throughout

Male holotype and female allotype from Fortin, Veracruz, October 9, 1941.

This species may be separated from *godmani* Laing by the more prominent eyes, more slender genal cones, deeper cells in the forewings, and differently proportioned genitalia.

The writer takes great pleasure in naming this species in honor of Dr Dwight M. DeLong.

Psylla minutiforma n. sp.

(Fig. 16.)

Length to tip of forewing, male 2. mm., female 2.3 mm.; forewing, male 1.6 mm., female 1.9 mm.

General color golden yellow over all with antennae black or dark apically.

Vertex almost twice as broad as long. Genal cones a third as long as vertex, thick, obtuse. Antennae scarcely longer than width of head. Forewings little over twice longer than broad; pterostigma very long, broad. Forceps of male invert L-shaped with apical arm a third longer than basal stem; there is a slight projection of the basal stem beyond the apical arm. Dorsal valve of female short, greatly narrowed apically.

Male holotype and female allotype from Tuxpan, Michoacan, Km. 168, October 5, 1941, and a male and female paratype from Zamora, Michoacan, Km. 458, October 2, 1941.

Psylla americana Crawford

Two species from Rio Frio, Puebla, October 7, 1941, on pine.

Psylla minuticona Crawford

Specimens from Chilpancingo, Iguala, and Mexacala, Guerrero, and from San Miguel in El Salvador, March 19, 1941, (Plummer).

A Modern Forestry Report

The most attractive paper bound book on the subject of forest resources that has been published in Ohio to date is the joint effort of the Agricultural Experiment Station and the Central States Forest Experiment Station staffs. Its colored cover is a reproduction of a photograph of a rolling farm landscape with some high grade timber logs ready for market. The back cover reprints a valuable essay by Louis Bromfield on the subject of conservation. Between these covers are maps, charts, photographs and significant discussion of our forest resources and problems. One fact out of many that is worth the reader's consideration is that while at present Ohio produces only 27% of all wood and 15% of timber consumed in the state, under forest management our people can bring that, over a period of years, to the point where consumption does not exceed annual growth increment. Just how this is to be accomplished is briefly suggested in the pamphlet. The reader is urged to concern himself in finding the answers.

Since such a publication issued for public distribution must be limited, it is hoped that it will reach those persons who will give it publicity or will reflect upon its findings. In attempting to cover the whole subject of forest planning and use, it is perhaps unavoidable that occasionally uneven treatment has resulted. Two staffs of specialists have engaged in the task. Yet on the whole there is a fine job of editing and co-operation, and it is to be hoped that more works of this type will be presented. The foreword by Mr. Secrest offers a unique reminder that during his career there has been a great change in viewpoint toward forestry. When he was himself almost the lone forester in the State of Ohio, the farmer and the forester were likely to be regarding each other antagonistically. It is significant of the modern perspective that we find a career forester the Director of an agricultural experiment station. As a progress report this paper is recommended to every reader of "The Ohio Journal of Science."—*A. E. Waller.*

Ohio's Forest Resources, edited by Oliver D. Diller. 109 pp., plus maps, charts, photographs. The Ohio Agricultural Experiment Station, Wooster, Ohio, in co-operation with The Central States Forest Experiment Station, Columbus, Ohio, 1944. No price indicated.

A NEW FISH SPINE FROM THE PENNSYLVANIAN OF OHIO

JOHN W. WELLS,
The Ohio State University

The species described below increases to two the number of species of the ichthyodorulite genus *Ctenacanthus* recorded from the Pennsylvanian rocks of Ohio, the other species being *C. marshi* Newberry, 1873.

Genus **Ctenacanthus** Agassiz, 1837

Ctenacanthus lamborni Wells, n. sp.

(Plate I, Figures 1–6.)

Description.—Based upon an imperfect spine, measuring 9.2 cm. in length, anteroposterior diameter 11 mm. at the outer end, 26 mm. at the inner end. Transverse diameter 11 mm. Inserted portion and distal end not retained. Radius of curvature of anterior edge, 17 cm. Pulp cavity at outer end nearly cylindrical, 1 mm. in diameter; at inner end compressed, 5 mm. by 12 mm., with posterior surface virtually flat. Anterior edge with a single continuous smooth rounded costa, 2 mm. across, 1.5 mm. high, the sides of which bear obsolescent tubercles. Posterior face nearly flat with closely spaced linear strips separated by rows of fine pores, its lateral margins rounded, 1.5 mm. higher than the face, and marked by well-developed rows of hooked denticles that represent a diminished extension of the lateral costae. Lateral surfaces ornamented with closely-spaced longitudinal costae that may be divided into two sets, anterior and posterior. The total number of costae ranges from 25–26 on the inner end to 17–18 on the outer, with 21 midway between, the increase in number proximally being due to bifurcation. The anterior set or group of costae consists of 9–10 large costae concentric with the outer curvature, 0.5–0.75 mm. thick, pectinated by transverse tubercles of which 6–9 occur in a space of 5 mm. The tubercles are further pectinated by rounded ridges transverse to their long axes. The posterior set is formed by 8–15 narrower costae, 0.2–0.5 mm. thick, concentric with the posterior curvature, pectinated by irregularly fluted tubercles of which 5–6 occur in a space of 5 mm. The most posterior of the costae of this set spiral gently over the margin where their tubercles are hook-shaped.

Occurrence and Material.—Ames limestone, Conemaugh group, Upper Pennsylvanian, east central part of Section 22, 0.75 miles east of Claysville, Guernsey County, Ohio. One specimen, collected by R. E. Lamborn (O. S. U. Geol. Mus. No. 19501).

Remarks.—When collected the spine was almost wholly enclosed in a small block of limestone, from which it was freed by etching with acetic acid. It is imperfect and lacks the proximal and distal portions, but is so clearly distinguished by its form and sculpture that it should easily be recognized when collected in the future.

Three other species of *Ctenacanthus* have been described from the Pennsylvanian of this country: *C. amblyxiphias* Eastman (1903, p. 186, pl. 2, figs. 22, 23; *non* Cope, 1891, p. 449, pl. 28, figs. 3a-c, *nec* Branson, 1916, p. 654, pl. 2, fig. 25, text fig. 5) from the Missourian group (Atchison shales) of Nebraska; *C. buttersi* St. John and Worthen (1883, p. 240, pl. 22, fig. 2) from the "shales over Coal No. 5" in Illinois; and *C. marshi* Newberry (1873, p. 326, pl. 36, figs. 3-3b) from near Zanesville, Ohio. Of these, *C. marshi* is marked by coarse, seemingly smooth and unornamented lateral costae; the others have finer, ornamented costae. *C. buttersi* has different proportions—larger radius of curvature and triangular cross-section with the posterior width nearly equal to the height, and strongly tuberculated rather than smooth anterior costa on the cutwater edge.

C. amblyxiphias was originally described from the Permian of Texas by Cope (1891). Later Hussakof re-figured Cope's type, repeated his description but added nothing further (1911, p. 161, pl. 30, figs. 6-6a). In the meantime Eastman (1903) referred two fragmentary spines from the Missourian of Nebraska to the species, but gave no description of them. Branson identified the species among the fish remains of the Ember formation (Permian) of Wyoming, and indicated that his specimens differed from Cope's in two respects: different ornamentation and no diminution of the costae posteriorly. However, study of Branson's figures suggests that there is a diminution in costal width posteriorly. As to the difference in ornamentation, it is unfortunate that he did not specify what that difference was, for his figures fail to show any, not being sufficiently enlarged.

C. lamborni, on the basis of Cope's description and figures and Hussakof's figure, has a costal arrangement and ornamentation like that of *C. amblyxiphias*, but they differ considerably in their cross-sectional proportions, as indicated by the following analysis:

	Transverse Posterior Diameter	Antero-Posterior Diameter	Ratio	Tubercles per 5 mm. on Larger Costae
C. amblyxiphias (Cope's descr.)	17 mm.	28 mm.	1 : 1.64	....
C. amblyxiphias (Hussakof's fig.)	15	28	1 : 1.93	6
C. amblyxiphias (Eastman's fig.)	. .	. .	....	5–8
C. amblyxiphias (Branson's reduced fig.)	4.5	11	1 : 2.44	....
C. lamborni n. sp. (proximal)	11	26	1 : 2.34	6–9
C. lamborni n. sp. (distal)	6	15.5	1 : 2.6	

Eastman's *C. amblyxiphias* at present cannot be definitely placed until more data on its proportions be obtained, but it may be suggested that it is not the same as the Permian *C. amblyxiphias* but either closely allied to or even identical with *C. lamborni*.

REFERENCES

1. **Branson, E. B.** 1916. *The lower Embar of Wyoming and its fauna.* Jour. Geol., Vol. 24, 639–664, 6 pls., 6 figs.
2. **Cope, E. D.** 1891. *On the characters of some Paleozoic fishes.* Proc. U. S. Nat. Mus., Vol. 14, 447–463, pls. 28–33.
3. **Eastman, C. R.** 1903. *Carboniferous fishes from the central western states.* Mus. Comp. Zool., Bull., Vol. 39, 163–226, 5 pls.
4. **Hussakof, L.** 1911. *The Permian fishes of North America.* In: E. C. Case, Revision of the amphibia and pisces of the Permian of North America. Carnegie Inst. Wash., Pub. 146, 155–175, pls. 26–32, figs. 53–56.
5. **Newberry, J. S.** 1873. *Descriptions of fossil fishes.* Geol. Surv. Ohio, Rep., Vol. 1, Geol. and Palaeont., Pt. 2, Palaeont., 247–355, pls. 24–40, 1 fig.
6. **St. John, O., and Worthen, A. H.** 1883. *Descriptions of fossil fishes.* Geol. Surv. Illinois, Vol. 7, Geol. and Palaeont., 57–264, pls. 1–26, 17 figs.

EXPLANATION OF PLATE I

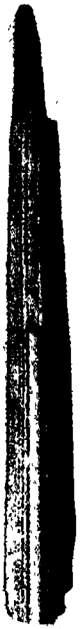
Ctenacanthus lamborni Wells, n. sp.

(All figures are of the holotype, O. S. U. 19501.)

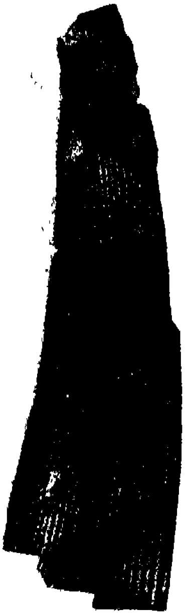
1, 2, 3. Anterior, lateral, and posterior aspects, ×1.

4. Outline of cross-section of spine at end of preserved proximal portion, ×1.

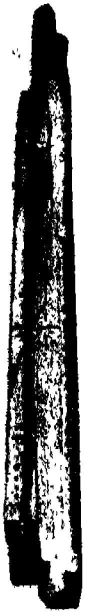
5, 6. Surface ornamentation of lateral costae, ×6. In upper quarter of both figures are the larger costae of the anterior group with their strongly compressed, pectinated, transverse tuberculations; in the lower three-quarters are narrower costae of the posterior group with the tubercles losing their regularity posteriorly and becoming subconical.



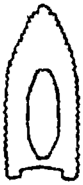
1



2

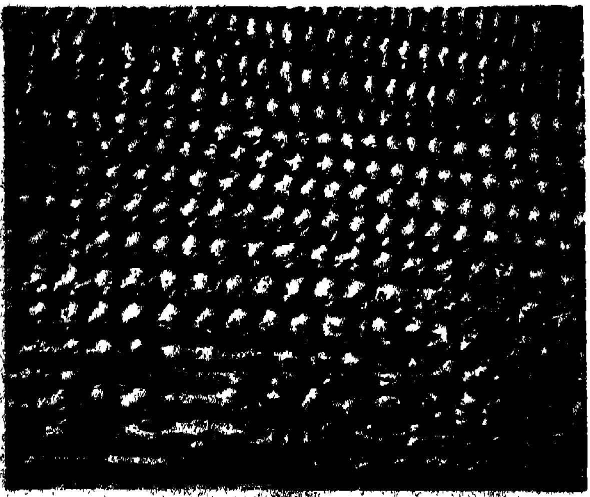


3



4

5



6

THE WINTER FISHERY IN WESTERN LAKE ERIE, WITH A CENSUS OF THE 1942 CATCH

KENNETH H. DOAN,
Franz Theodore Stone Laboratory, The Ohio State University,
Put-In-Bay, Ohio

In the island region of western Lake Erie a hook and line fishery operates on a commercial basis during the period of a year when the lake is covered with ice in that vicinity. The center of this fishery is Put-In-Bay on South Bass Island. No nets are employed in this winter fishery.

The fish captured are of high quality and the catch is of sufficient magnitude to be of importance in the regional economy, although the quantity is but a small fraction of the annual yield of the whole lake. A creel census was placed in operation during the winter of 1942, and, when compared with returns of hook and line fishermen in other water areas, the yield was high.

HISTORY OF THE FISHERY

Presumably the earliest fur traders and settlers on the Lake Erie islands were familiar with the practice of fishing for food with hook and line through holes in the ice. Until about 1890 fishing was a casual affair, since not much effort was required to take ample supplies of herring, *Leucichthys artedi albus* (LeSueur), for domestic consumption. The fisherman squatted at the edge of a round hole in the ice and used a stick attached to which was a short line bearing a small hook baited with a pearl button or a piece of cloth. This type of fishing, confined mostly to the protected harbor, yielded ample supplies of jumbo herring averaging about 18 inches in length.

When shanties first came into use about 1890, they were built of wood and were heavy, semi-permanent structures that required considerable exertion to bring into position on the ice. With the adoption of the shanty, fishing extended out from the harbor to more exposed situations over deeper water. About 1895 the first shanty was built with a canvas covering over a wood frame. This newer and lighter shanty, mounted on runners, met with general favor so that in succeeding years the number on the ice increased from 50 to as many as 250 shanties. The first wooden shanties were frequently built with several holes in the floor, and accommodated up to half a dozen fishermen. The present canvas shanties are small, coal-heated, one-man shelters, but are occasionally large enough to hold two fishermen. The early fishing gear of two or three lines each with a single hook was modified, between 1910 and 1920, to the present standard equipment of two lines per man, each line with a heavy flat weight, a spreader, and two hooks.

Catches of fish in the early days were generally greater than at the present time. Notably abundant then were herring, a rarity in recent winter catches. Sauger, *Stizostedion c. canadense* (Smith), were taken more abundantly then than now, a fisherman sometimes catching in a day two bags of "clear" sauger (a catch composed of sauger only). Catches of perch, *Perca flavescens* (Mitchill), have always varied greatly throughout the years. The catch of three tons of No. 1 yellow pickerel, *Stizostedion v. vitreum* (Mitchill), in a single day was an outstanding event in 1910.

The sizes of fish caught have also varied. Large pickerel were more frequently encountered forty years ago than now, and fish of 9 and 10 pounds were common. One fisherman at that time caught in one day, two very large pickerel, 17 and 18½ pounds; another caught four 12-pound pickerel before 9:00 A. M. and several 8- and 9-pound fish later the same day. Big sauger, now largely unknown, were quite usual. The size of perch has been maintained throughout the period of the fishery, generally at about three fish to the pound.

Fluctuations in market prices and demand have had an effect on the size of the catch. Sometimes in the 1890's fishermen were unable to sell their fish at any price; at other times in the same years they accepted ¾c. pound for perch, 1c. pound for sauger, and 3c. pound for pickerel and herring. In later years as many as five buyers competed for the catch, and prices were forced higher. During the war of 1914–1918, prices of pickerel reached a peak of 20–25c. pound. In 1942 fishermen received 10c. pound for perch and sauger, 12c. pound for No. 2 pickerel, and 14c. pound for the larger No. 1 pickerel.

The hauling of local wines to the mainland and city markets by teams and sleighs was formerly an important winter industry on the islands, but fish were regarded as of minor importance as a freight load. With intermittent hauling facilities, fishermen were not assured of steady marketing of their fish, and the fishing industry did not become stabilized.

Beginning about 1900, mail, passengers, and freight including fish were carried to the mainland in winter by regular contractors who used iron-clad boats capable of travel over both water and ice. Regularly scheduled trips could be depended upon, except during violent extremes of weather, and additional iron-clads were put into service solely for the fish trade. Two men could carry four 250-pound barrels of fish in one boat, and sometimes completed three round trips daily to the mainland, about 3½ miles distant. The fish-carrying ironclads occasionally transported as much as three tons of fish daily, and the winter fishing industry thus proceeded on a firmer basis.

The final development in the improvement of the island fishing industry was the permanent establishment of an airplane freight service which has carried fish dependably and continuously each winter since 1931–32.

Before the present century fish were readily available, but, owing to low prices, daily incomes generally amounted to $3 or $4, and sometimes up to $7 per fisherman. The wages of the men engaged in the transportation of fish were about the same as those of the fishermen. More recently, even with satisfactory ice conditions, fish have sometimes been caught with greater difficulty; fifty days of fishing in 1933 resulted in earnings of $57 for one fisherman. At other times the fortuitous combination of moderate numbers of fish with high prices has resulted in individuals making catches of outstanding value: $78-worth of fish in three days, and $31 in one day are instanced.

Yellow pickerel, perch, sauger and herring have constituted the chief species entering the fishery, and in some seasons there has been a market for lawyers, *Lota lota maculosa* (LeSueur), but the fishermen were required to dress these fish before the buyers would accept them at 1c. pound. Herring have been of no importance for about the last twenty years.

The capture of lake shiners, *Notropis a. atherinoides* Raf., for bait has generally been simple, as they were usually plentiful and readily available. Sometimes shiners were so abundant that fishermen did not bother to keep a live-box, but in the morning on the way out to the shanty stopped in a bay where in a few minutes they would easily catch a day's supply with a few hauls of a circular dip net through a hole in the ice. At other times shiners were more difficult to catch, and their extreme scarcity in 1912 was paralleled by that in 1942. The catching of shiners for bait has been a commercial effort by one or two men each year, and prices have been as high as $2 quart, but average about 50c. quart, there being approximately 400 shiners in a quart.

THE CENSUS

Methods—

In most creel census operations it has been customary for the census-taker either to talk with the fishermen while they were angling, to meet the fishermen at a dock or other point of egress from the fishing waters, or to set up census stations at points about the lake where cards were available for the voluntary use of anglers. In this census, the practice of obtaining data has been simplified because most of the catches eventually passed through the hands of only two buyers, and both have furnished records of the number of pounds of fish purchased each day.

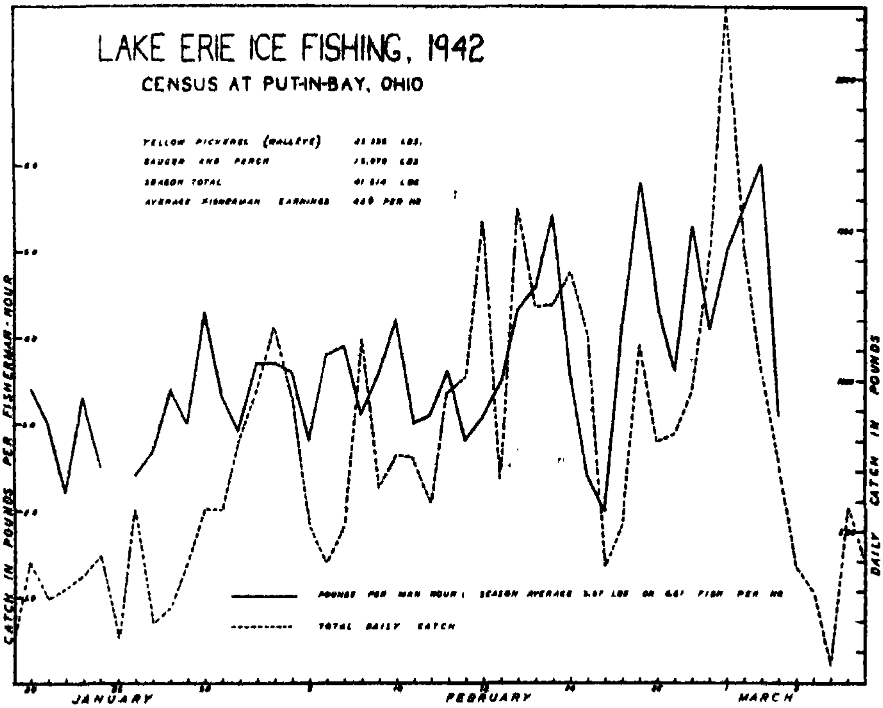


FIGURE 1. Graph showing fluctuations in daily total catch and in daily catch per man-hour in the winter hook and line fishery. Yields increased irregularly with progress of the season.

The Port Clinton Fish Company purchased about 65 per cent of the total catch, and collected data for 58 per cent of the total catch on the number of hours occupied by each fisherman to catch the fish which he offered for sale. It is these data which form the basis for calculations of effort. Effort refers to the number of pounds of fish caught per man-hour; perhaps it should more properly refer to the time required to catch a unit weight of fish, but the former definition of the term has been adopted in this report.

In the calculation of a daily average of effort, two procedures could be used. The first would be to find the simple mean of individual efforts for the day; this might be regarded as a better measure of availability, since it does not give undue weight to either the poor or successful fisherman. The second method would be to calculate the daily mean effort by weighting individual efforts according to the number of hours fished; or, in practice, to divide the total catch for the day by the total number of hours fished. This mean could be construed as a true measure of the average return per hour for all fishing.

Since this report may possibly have more value if calculations are based on the average return per hour for all fishing, the weighted mean has been used. However, simple means have also been calculated, but the two means have not differed by more than 0.39 pounds per hour, of total catch, on any one day, and have differed by less than 0.10 pound per hour throughout 64 per cent of the season. Weighted averages have also been employed in the comparison of catches over periods of several days or weeks, and in the treatment of financial returns to the angler.

The poundages of fish listed in Table I do not indicate the total yield. Fish that were sold conformed to minimum size limits of one pound for No. 1 pickerel (about 15 inches total length), 13 inches for No. 2 pickerel, 11 inches for sauger, and 8 inches total length for perch. Undersized fish were taken for home use, and non-resident sportsmen also caught a proportion of the total yield; however, the fish not offered for sale probably constituted not more than 20 per cent of the total catch, or about four tons. Because buyers paid the same price for sauger and perch, poundages of these fish were generally listed together on the sales slips,[1] so that efforts for these species individually were not available throughout the season.[2]

TABLE I

HOOK AND LINE CATCHES IN THE WINTER FISHERY IN LAKE ERIE AT PUT-IN-BAY, OHIO, FROM JANUARY 17 TO MARCH 13, 1942.

MONTH	CATCH IN POUNDS, AS REPORTED BY DEALERS							
	YELLOW PICKEREL				SAUGER	PERCH	NOT SPECIFIED SAUGER AND PERCH	TOTAL CATCH
	No. 1	No. 2	Not Specified	Total				
January	661	2,295	1,227	4,183	271	703	623	5,780
February	1,503	14,132	.	15,635	3,700	4,077	3,147	26,559
March	920	4,797	..	5,717	907	1,018	1,533	9,175
Totals	3,084	21,224	1,227	25,535	4,878	5,798	5,303	41,514
Per cent of total catch	7.4	51.1	3.0	61.5	11.8	14.0	12.8	

Catch—

The winter catch of fish in Lake Erie at Put-In-Bay, as reported by commercial dealers, has averaged about 44,500 pounds from 1935 to 1940, and has been composed of 70 per cent pickerel, 24 per cent perch, and 6 per cent sauger. During this period the winter catch of pickerel, perch, and sauger has amounted to 1.04, 0.31, and 0.23 per cent, respectively, of the annual catch of these three species by commercial nets in the Ohio portion of Lake Erie.

---

[1] Blue pike, *Stizostedion vitreum glaucum* Hubbs, were taken in small amounts, and have been included with sauger.

[2] Total catches, apart from the data on effort, were obtainable by species.

The winter fishing season in 1942, as regulated by the period of ice-cover on the lake, extended from January 17 to March 13, and data on effort are available between January 20 and March 4, for which catches, efforts, and fishermen's earnings are presented in Tables I and II.

The trend of success in fishing evidenced an irregular increase from a minimum average catch of 2 pounds per hour of all species near the beginning of the season to a maximum daily average of 6 pounds per hour in early March, as shown in Figure 1. The season's average rate of catch was 3.67 pounds per fisherman-hour.

Yellow pickerel constituted 61.5 per cent of the total yield of the winter fishery in 1942, and these fish were taken at the rate of 2.34 pounds per hour (2.03 pounds per hour of No. 2, and 0.31 pounds per hour of No. 1 pickerel). Perch and sauger, which composed the remaining 38.6 per cent of the total catch, were together caught at the rate of 1.33 pounds per hour.

TABLE II

AVERAGE FISHING EFFORTS IN THE WINTER HOOK AND LINE FISHERY IN LAKE ERIE AT PUT-IN-BAY, OHIO, 1942.

	Number of Fisherman Reports	Average Length of Fisherman-day, in Hours	Yellow Pickerel			Sauger	Perch	Sauger and Perch	Total, All Species	Average Fisherman Earnings Per Hour
			No 1	No. 2	Total					
Pounds of fish caught per fisherman hour.										
Jan. 20–Jan. 31	116	8.1	0.51	1.90	2.41			0.67	3.08	$0.308
Feb. 1–Feb 15	307	8.3	0.23	1.70	1.92			1.37	3.29	0.374
Feb. 16–Feb. 28	274	8.5	0.23	2.22	2.44			1.49	3.94	0.448
Mar. 1–Mar. 4	77	8.9	0.59	2.88	3.47			1.51	4.98	0.575
Season total, or average	774	8.4	0.31	2.03	2.34			1.33	3.67	0.421
Average weight per fish, in lbs.	. .	. . . .	1.54	0.70	. .	0.46	0.33		.	. . .
Calculated number of fish caught per fisherman-hour (Season average)	. .	. . .	0.20	2.90	.	1.33	2.18	.	6.61	.

COMPARISON WITH HOOK AND LINE FISHING IN OTHER LAKES

Many creel censuses have expressed the results in fish per hour, without conversion into the more comparable expression of rate of catch in pounds. It is generally safe to assume that for most fishing areas the figure representing catch in fish per hour is greater than that of catch in pounds per hour.

Fishing in a group of Michigan lakes yielded average catches of 0.4 fish per hour and 1.1 fish per hour in summer (Hazzard and Eschmeyer, 1937); winter catches in several other lakes in Michigan varied between 0.1 and 1.7 fish per hour, and summer catches in the same lakes from 0.4 to 2.5 fish per hour (Hazzard and Eschmeyer, 1938). Surveys in seven Ohio lakes showed catches of 1.30 to 4.77 fish per hour in summer and autumn (Wickliff, 1936). Catches in the spring, summer and autumn in some Wisconsin lakes have been reported at the rate of

1.24 to 1.86 fish per hour (Frey, Pedracine, and Vike, 1939), and 0.90 to 1.53 pounds per hour (Frey and Vike, 1941). Fish have been taken in the summer by anglers in several Algonquin Park lakes, Ontario, at the rate of 0.66 to 2.56 fish per man-hour (Hart, 1941), and at rates of 0.54 to 3.20 fish per boat-hour (Kennedy and Banfield, 1942).

Spring and summer fishing in Illinois have yielded results of 4.37 fish per hour (Bennett, Thompson, and Parr, 1940). Angling throughout the year, or portions of it, in several reservoirs and their tributaries in Alabama and Tennessee gave catches of 0.2 to 1.4 fish per hour (Eschmeyer and Tarzwell, 1941; Tarzwell, 1941).

The average daily catch made by hook and line fishermen operating through the ice in the island section of western Lake Erie amounted to 3.67 pounds, or 6.61 fish, per fisherman-hour between January 20 and March 4, 1942. In general, this is a higher rate of return to the angler than in most fisheries elsewhere and in various seasons of a year.

ACKNOWLEDGMENTS

The creel census was conducted under the direction of Dr. T. H. Langlois, and with the cooperation of other members of the staff of the Laboratory. Assistance in the collection of data was received from the Ohio Division of Conservation and Natural Resources. The author is indebted to Drs. W. E. Ricker and R. Hile for discussion of weighted and simple means in the measure of fishing effort.

LITERATURE CITED

Bennett, G. W., D. H. Thompson, and S. A. Parr. 1940. Lake management reports. 4. A second year of fisheries investigations at Fork Lake, 1939. Ill. Nat. Hist. Surv., Biol. Notes, 14, pp. 1–24.

Eschmeyer, R. W., and C. M. Tarzwell. 1941. An analysis of fishing in the TVA impoundments during 1939. Jour. Wild. Manag., Vol. 4, pp. 15–41.

Frey, D. G., H. Pedracine, and L. Vike. 1939. Results of a summer creel census of lakes Waubesa and Kegonsa, Wisconsin. Jour. Wild. Manag., Vol. 3, pp. 243–254.

Frey, D. G., and L. Vike. 1941. A creel census on lakes Waubesa and Kegonsa, Wisconsin, in 1939. Trans. Wis. Acad. Sci., Arts and Lett., Vol. 33, pp. 339–362.

Hart, J. S. 1941. The availability of smallmouth black bass, *Micropterus dolomieu* Lacépède, in lakes of Algonquin Park, Ontario. Trans. Am. Fish. Soc., Vol. 70, pp. 172–179.

Hazzard, A. S., and R. W. Eschmeyer. 1937. A comparison of summer and winter fishing in Michigan lakes. Trans. Am. Fish. Soc., Vol. 66, pp. 87–97.

1938. Analysis of the fish catch for one year in the Waterloo Project Area. Pap. Mich. Acad. Sci., Arts, and Lett., Vol. 23, pp. 633–643.

Kennedy, W. A., and A. W. F. Banfield. 1942. Report on angling, Cache and neighboring lakes, summer 1941. Ont. Fish. Res. Lab., Univ. of Toronto, pp. 1–10. Mimeo.

Tarzwell, C. M. 1941. A second season of creel census on four Tennessee Valley Authority reservoirs. Trans. Sixth North Am. Wildlife Confer., pp. 202–221.

Wickliff, E. L. 1936. Summary of preliminary creel census for seven Ohio lakes during the spring, summer and fall of 1935. Ohio Div. of Conserv., Bull. 95. Mimeo.

The Way of a Naturalist

This delightful volume combines the best characteristics of an interesting book of travel, an authentic natural history guide, and an intimate and charming autobiography. The animal life and the people of the South Pacific, the Dutch East Indies, Latin America, Africa and other far-flung places unfold in a succession of amusing and whimsical anecdotes. The inner workings of a great museum are told in a way that is seldom vouchsafed the public. Many of the great biologists of the recent past are portrayed vividly by Dr. Barbour, whose pen moves with amazing facility from people to places, from museums to caves, from meals to scientific language.

—*L. H. Snyder.*

Naturalist at Large, by Thomas Barbour. xii+314 pp. Boston, Little Brown and Co., 1943. $3.50.

SANDSTONES AND CONGLOMERATES IN OHIO

WILBER STOUT,
Geological Survey of Ohio,
Columbus, Ohio

TABLE OF CONTENTS

PAGE
INTRODUCTION ... 75
DEFINITION OF TERMS ... 76
GENERAL OCCURRENCE ... 76
CAMBRIAN SYSTEM ... 76
ORDOVICIAN SYSTEM ... 77
SILURIAN SYSTEM ... 77
  Clinton Sandstone ... 77
DEVONIAN SYSTEM ... 77
  Oriskany Sandstone ... 78
MISSISSIPPIAN SYSTEM ... 78
  Euclid Sandstone ... 78
  Berea Sandstone ... 78
  Buena Vista Sandstone ... 79
  Black Hand Sandstone ... 79
  Byer Sandstone ... 80
  Allensville Conglomerate ... 81
  Vinton Sandstone ... 81
PENNSYLVANIAN SYSTEM ... 81
  Pottsville Series ... 81
    Sharon Conglomerate ... 82
    Massillon Sandstone ... 82
    Homewood Sandstone ... 82
  Allegheny Series ... 83
    Clarion or Hecla Sandstone ... 83
    Lower Freeport Sandstone ... 83
    Upper Freeport Sandstone ... 84
  Conemaugh Series ... 84
    Lower Mahoning Sandstone ... 84
    Buffalo Sandstone ... 85
    Cow Run Sandstone ... 85
    Morgantown Sandstone ... 85
  Monongahela Series ... 86
    Upper Sewickley Sandstone ... 86
PERMIAN SYSTEM ... 86
  Dunkard Series ... 86
    Upper Marietta Sandstone ... 86
    Hundred Sandstone ... 87
USES OF SANDSTONES, CONGLOMERATES AND SAND ... 87
  Sandstone for Abrasive Purposes ... 87
  Sand for Abrasive Purposes ... 87
  Sand for Railroad Use ... 87
  Sand for Filtering Purposes ... 87
  Sand for Foundry Purposes ... 87
  Sand for Ceramic Uses ... 87
  Sandstone for Refractory Purposes ... 87
  Sand for Refractory Purposes ... 88
  Uses of Sandstone Formations under Deep Covering ... 88
  Various Uses for Conglomerates or Pebbles Therefrom ... 88
  Sand Used in Building Materials ... 88
  Sandstone for Construction Purposes ... 88
  Silica for Chemical Uses ... 88
  Finely Ground Sand ... 88
  Other Uses ... 88

INTRODUCTION

The pioneer settlers, mainly through necessity, first turned the local sandstones in the eastern half of Ohio to profitable account in the construction of homes, mills, factories, dams, bridges, canal locks, furnaces, cupolas, public buildings, etc. Such rocks were widely distributed over that area, had outcrop exposures favorable for quarrying, were readily fashioned by the mason into desired forms and, in general, were pleasing to the eye or appealed to the sense of durability. The first homes were built of logs but in these the chimneys most commonly were constructed of sandstones laid in mud. For example at Schoenbrun, established by the Moravians in 1792 and burned soon after by the whites, the locations of the old buildings were established by the hearthstones and the corner foundations hid during the lapse of time. The dams of early mills, built from 1790 on, used rock of some kind for the entire structure, for the shore anchors or for weighting the timbers if made of wood. Piles of moldering sandstones still mark the sites of Hopewell furnace built in 1804, Montgomery in 1806, Rebecca in 1807, Licking in 1808, etc. The remaining evidence for the first paper mill west of the Allegheny Mountains, and built on the Little Beaver Creek in 1805, is remnants of the stone abutments on the shores and a row of holes in the rocks forming the floor of the stream. Such instances may be duplicated many, many times and with a wide variety of older works.

DEFINITION OF TERMS

Sandstone may be defined as a rock of sedimentary origin derived by consolidation of sand through compaction and cementation by bonding components. The sand grains may be nearly pure quartz or quartz with feldspar, mica, zircon, rutile, garnet and other minerals. In size the grains may vary from fine to coarse but in any given rock they are usually rather well sorted. The common bonding components are iron oxides in some form, silica, either amorphous or crystalline, and carbonates of calcium and magnesium. Others less abundant but common are phosphates, organic matter and manganese oxide.

Conglomerate is a consolidated water-lain rock made up partially or nearly wholly of pebbles, usually rounded, embedded in a matrix of finer material, generally sand. The pebbles may be derived from most any kind of hard rock but those from quartz or quartzite are the most common. Usually the conglomerate rock is a massive stratum varying both vertically and laterally from a sandstone with few pebbles to one made up largely of the coarse material, the sand filling only interstitial space. Cross-bedding and lenticularity are conspicuous features of most conglomerates when viewed in mass.

GENERAL OCCURRENCE

In Ohio sandstones and conglomerates occur at various horizons throughout the entire rock column of some 6,800 feet from the basement pre-Cambrian crystallines to the upper-most strata of the Permian system. However, the quantity of such strata varies greatly in the different systems being abundant in some and nearly absent in others. On account of so much variation and so many wants with the sandstones and conglomerates a true estimate is hardly possible. However, the data given below are relatively accurate.

System	Total Thickness of Rocks, Feet	Total Thickness of Sandstone and Conglomerate, Feet
Permian	626	147
Pennsylvanian	1,115	355
Mississippian	675	375
Devonian	770	5 ?
Silurian	800	20
Ordovician	2,095	0 ?
Cambrian	720	360
	6,801	1,105

Thus an abundance of siliceous strata is present in the Mississippian, Pennsylvanian, Permian and Cambrian systems whereas an impoverishment of such materials prevails in the Ordovician, Devonian and Silurian systems, the latter three being made up of dolomites and limestones with minor quantities of shale.

CAMBRIAN SYSTEM

In the Vance[1] and some ten other wells in the western half of Ohio that have penetrated the strata from the base of the great Trenton-Black River group to the crystalline gneisses and schists many sandstone lenses, some quite thick, are interspersed in dolomite in the basal 720 feet or more of the section. Here, the sandstones, either pure or dolomite bonded, make up more than half of the deposits. In the Vance and also in a few of the other wells with detailed sections, the sandstone most conspicuous lies directly above the crystalline rocks, is exceptionally pure and measures 125 feet or more in thickness. These sandstones provide excellent reservoirs for the accumulation of petroleum, natural gas and brine but so far they have yielded only the latter. The brine[3] is highly concentrated and is of value for the chemical industries. In the Vance well it was found at a depth of 3,820–3,825 feet.

---

[1] See "Paleozoic and pre-Cambrian Rocks of the Vance Well, Delaware County, Ohio," by Wilber Stout and Carl A. Lamey, The Bulletin of The American Association of Petroleum Geologists, Vol. 24, No. 4, April, 1940, page 687.

ORDOVICIAN SYSTEM

The rocks of the Ordovician system, some 2,095 feet in thickness, are nearly entirely dolomites, limestones and calcareous shales. The only well known and definitely correlated sandstone in the system is the St. Peter lying at the base of the Black River formation. However, this member is largely wanting and when present thin and impure. The horizon yields a weak brine and the green shale and dolomite, 10 to 15 feet above the disconformity, have furnished in scattered wells small quantities of petroleum and natural gas.

SILURIAN SYSTEM

Throughout this great system of rocks, about 800 feet in thickness, the dominating deposits are dolomites, calcareous shales and limestones, many of which are of great interest industrially. The only sandstone of any importance is the Clinton of the driller which is of Medina age and correlative with the Whirlpool sandstone of the Niagara Gorge (New York) section.

CLINTON SANDSTONE

The Clinton sandstone of the driller in Ohio is of Medina age and is correlative with the Whirlpool sandstone of the Niagara Gorge (New York) section. Its position is directly above the Elkhorn or Queenstown or "Red Medina" shale and from 100 to 250 feet below the base of the well known Niagara dolomites. This formation enters Ohio from the east or northeast, thins rapidly westward and becomes absent or very indefinite in the east central part. Its western boundary is marked roughly by a line from Lorain on Lake Erie through Mansfield, Mount Vernon, Lancaster, Laurelville and Jackson to Ironton on the Ohio River. It is not known on the outcrop in southwestern Ohio. The Clinton sandstone varies from 1 to 100 feet or more in thickness, is always fine in texture and in the eastern part of the state is cemented to a hard quartzitic rock. However this sandstone is the reservoir for the great natural gas and petroleum fields stretching nearly continuously from Cuyahoga and Lorain counties on the north to Lawrence County on the south. Throughout the field, opened near Lancaster in 1887 and still active, over 26,000 wells have been drilled yielding immense volumes of natural gas and large supplies of petroleum. It has proved one of the most valuable formations in Ohio.[4]

DEVONIAN SYSTEM

The rocks of the Devonian system in Ohio are all of marine origin, average between 700 and 800 feet in thickness and include, in order of abundance, shale, limestone, dolomite and sandstone, the latter forming a very minor part of the whole. The siliceous strata comprise the Oriskany sandstone at the base of the system and the Marcellus, Olentangy and Ohio shales in the middle and upper portions.

---

[3] *Ibid.* Pages 673–4.

[4] For reference see: Geol. Sur. Ohio, Vol. VI, pages 12, 75, 354 and 783; Geol. Surv. Ohio, Bull. 1, "The Occurrence and Exploitation of Petroleum and Natural Gas in Ohio," pages 20, 101, 120; Geol. Sur. Ohio, Bull. 12, "The Bremen Oil Field," pages 16, 17, 22, 23, 24, 38, 65; also Bulletins 20, 21, 24, 28, 31, 35, 37.

ORISKANY SANDSTONE

The type locality for the Oriskany sandstone is Oriskany Falls, Oneida County, New York. The formation extends westward from New York through Pennsylvania into eastern Ohio, becomes absent in the central part of the State but appears again in the northwestern portion. In the latter area it is known as the Sylvania sandstone. The formation is erratic in thickness varying from 1 to 100 feet but ranging usually between 10 and 40 feet. Its chief economic value is for the production of natural gas and petroleum, the chief fields being in Ashtabula, Tuscarawas, Guernsey, Coshocton and Muskingum Counties. Formerly the Sylvania sandstone of northwest Ohio was used in glass making and was ground to a fine powder for potters flint, paint pigment and foundry uses.[4]

MISSISSIPPIAN SYSTEM

Aside from the Maxville limestone placed at the top of the section but absent over much of the area the rocks of the Mississippian system are entirely siliceous in character, that is, they are sandstones or siliceous shales. The total thickness of these strata varies from place to place but on the average approximates 675 feet. The deposits are wholly marine in origin and show much evidence of shallow water deposition. The system outcrops in a wide belt extending northward from Scioto County on the Ohio River to Lorain and Medina Counties thence eastward to Trumbull County on the Ohio-Pennsylvania line. The shales are employed extensively for ceramic products and the sandstones have proved useful for building stone, abrasives, oil and gas, brines, fire stone, glass sand and molding sand.

EUCLID SANDSTONE

Although the Bedford formation primarily is shale yet in some areas it bears thin to medium bedded layers of sandstone either closely or widely spaced in the shale. In the Cleveland district this sandstone has long been quarried under the name of "Euclid bluestone," is dense and fine grained and weather resistant. The deposits range from 15 to 30 feet in thickness and the individual layers from 2 inches to 3 feet 6 inches. It finds employment for flagging, foundations, cellars and when sawed for caps, sills and steps.[5]

BEREA SANDSTONE

The Berea sandstone of Mississippian age, and named by Newberry in 1870, is one of the best known rocks of this class in Ohio. It is important along the outcrop as a source of building stones and abrasives and under deep covering as a storage reservoir for petroleum, natural gas and salt brines. The formation expands 5 to 225 feet in thickness but averages about 45 feet. The typical stone is massive in structure, medium fine in grain size, rather open in texture and light gray to slight buff in color. It quarries with good economy and works well either by chipping or sawing. The outcrop of the Berea sandstone is marked in a general way by small or large quarries in Trumbull, Ashtabula, Geauga, Lake, Cuyahoga, Lorain, Erie, Huron, Crawford, Morrow, Delaware, Franklin, Pickaway, Ross, Pike, Scioto and Adams Counties. The most prominent quarries are confined to northern Ohio in Lorain, Cuyahoga and Erie Counties. The uses of the Berea sandstone are many, principal among them are building stone, curbing, flagging and riprap. It is the chief source in the United States for grindstones, whetstones and related rubbing stones. Formerly it was used for mill stones for grinding barley and other grains. Of recent years a new and important use is sawed stone for refractory linings of cupolas, in replacement of silica brick. Such blocks are cheap, stand up well against heat and slag and are easily replaced.

---

[4] For reference see: American Association of Petroleum Geologists, "Natural Gas in Central and Eastern Ohio," June, 1935, page 907.

[5] For detail see: "Geology and Mineral Resources of the Cleveland District," U. S. Geol. Sur. Bull. 818, pages 107–111; "The Devonian and Mississippian Formations of Northeastern Ohio," Geol. Sur. Ohio, Bull. 15, page 51; "Building Stones of Ohio," Geol. Sur. Ohio, Bull. 18, pages 69–70.

The Berea sandstone ranks third in the production of petroleum and natural gas, being surpassed only by the Trenton and the Clinton. From the Berea the yield has been largely oil. The depth of the wells varies from 100 to 2,000 feet or more. On the average the wells are not large producers but are long lived. The largest pools are in Athens, Washington, Perry, Morgan, Muskingum, Noble, Monroe, Belmont, Harrison, Jefferson, Carroll, Columbiana and Mahoning Counties. Some production is also obtained in Gallia, Meigs, Vinton, Hocking, Guernsey, Coshocton, Tuscarawas, Holmes and Stark Counties. This formation is a consistent producer of brine except where structural relief is such as to impede its migration. The flow of brine, however, is not large nor is the concentration especially strong, the yield of salts in the brine varies greatly but commonly ranges from 50 to 150 grams per liter. Formerly brine from the Berea sandstone was utilized for salt making near Dover in Tuscarawas County and at Lisbon and Salineville in Columbiana County.[6]

BUENA VISTA SANDSTONES

The Buena Vista formation is recognized as such from the Ohio River in Adams County northward to near Mansfield in Richland County, beyond which it breaks up and becomes more indefinite. It is made up of a great series of sandstone and shale layers occupying from 100 to 150 feet of the lower part of the Cuyahoga formation. Such deposits are best developed in western Scioto, eastern Adams and western Pike Counties. The sandstone beds vary from one inch to six feet in thickness, but the majority are under 16 inches. Further, they maintain remarkable regularity in their lateral extension. These sandstones are fine in texture, break well in any direction, are bluish gray to rich brown in color and are firmly cemented with clay matter and iron oxides. At present the active quarrying is largely confined to McDermott in Scioto County. Formerly, however, the deposits were worked in a large way at Buena Vista, Rarden, Henly, and Carey Run in Scioto County, Piketon and Waverly in Pike County, at Lithopolis in Fairfield County, and Blacklick in Franklin County. In southern Ohio the output consists of sawed stone for building, grave vault, flagging, curbing purposes and perch stone for bridges, abutments, retaining walls and foundations.

The Buena Vista sandstones also produce petroleum and natural gas, especially the latter, under the driller's term of Hamden sand of Jackson and Vinton Counties, Weir of West Virginia and Welsh Stray of Monroe County. In Ohio the outstanding gas pool is near Hamden in Vinton and Jackson Counties.[7]

BLACK HAND SANDSTONE

The Black Hand formation forms conspicuous deposits along the outcrop in central Ohio from southwestern Hocking County through Fairfield, Licking and Knox Counties to north of Mansfield in Richland County. Further it extends on southeastward under deep covering into West Virginia as shown by the drill. It is a massive deposit, often one great ledge with few if any distinct stratification planes. It varies in thickness from 50 to 200 feet or more. The stone changes in texture from a coarse-grained sandstone to a rather pebbly conglomerate. Commonly, however, it is a sandstone with pebbles scattered through the mass or concentrated to local lenticular layers. The stone is generally highly cross-bedded, the planes being confined to definite lenticular boundaries which are rather closely spaced. Outstanding features are thus cross-bedding and lenticularity. The usual cementing medium is iron oxides. This sandstone is commonly of a decided buff color but locally this changes to light, light gray, pink, reddish and brown

---

[6] References: Geol. Sur. Ohio, Bull. 18, "Building Stones of Ohio," pages 72–118; Geol. Sur. Ohio, Bull. 1, "The Occurrence and Exploitation of Petroleum and Natural Gas in Ohio," many references; The American Association of Petroleum Geologists, June, 1935, pages 904–5; Geol. Sur. Ohio, Bull. 37, pages 14–16, 52–63.

[7] Geol. Sur. Ohio, Bull. 18, "Building Stones," pages 108, 122–129; Bull. 23, "Geology of Camp Sherman Quadrangle," pages 104, 113, 156.

This sandstone has been used since pioneer days but in a rather desultory way for building stone and heavy masonry. It has been quarried for such purposes near Mansfield in Richland County, along the Licking River at Hanover and Toboso in Licking County, along the Hocking River at Lancaster and Sugar Grove in Fairfield County and at Rockbridge and Logan in Hocking County Through crushing followed by screening, air separation or washing, the Black Hand sandstone finds employment on the markets for molding sand, mortar sand, sand finish of plastering, sand blasting, engine sand and glass sand. The largest active plant (1943) is at Millwood in Knox County, preparing glass sand by acid treatment and washing.

To the driller the Black Hand sandstone is known as the Big Injun sand. When detached from the main body the lower portion is called the Squaw sand. These sandstones produce both petroleum and natural gas, but largely the latter. The Big Injun sand is of most importance in Washington and Monroe Counties and of less worth in Athens, Vinton, Morgan, Muskingum, Noble, Guernsey and Belmont Counties.

In the Pomeroy district of Meigs County the Black Hand sandstone is one of the important sources of brine for the salt industry. Formerly such brines were used extensively along the Hocking River and along Sunday Creek in northern Athens County and along the Muskingum River in southern Muskingum and northern Morgan counties. This formation yields a large flow of concentrated brine which is high in bromine and practically free from sulphates.

The Black Hand sandstone is of value also for the picturesque and attractive scenery presented along the outcrop. The deeply entrenched gorges, box caverns, falls and cascades and bold cliffs yield recreation places and camp sites of value for scenery, wild life and pleasure. Ash Cave, Cedar Falls, Old Man's Cave, Conkle Hollow, Rock House, Cantwell Cliffs, Clear Fork, Jacob's Ladder, Christmas Rock, Mt. Pleasant, Licking Narrows, Rain Rock and Kokosing gorge are some of the outstanding spots that may be mentioned.[8]

BYER SANDSTONE

The Byer sandstone belongs near the base of the Logan series of the Mississippian system. This formation at the type locality, Byer in northern Jackson County, is a fine grained, even bedded sandstone of a yellowish or buff color. The bonding components, consisting of clay matter and iron oxides, are rather high, but the stone is only locally weather resistant. In many areas more or less of the sandstone is replaced by gray siliceous shale. The thickness of the Byer formation is about 60 feet in Scioto County, 70 feet in Vinton, 100 feet in Ross and 70 feet in Wayne. Economically it is of small worth, supplying only small quantities of building stone for local needs.[9]

---

[8] For reference see: Geol. Sur. Ohio, Bull. 37, "Brines of Ohio," pages 22, 23, 47-52; Bull. 18, "Building Stones," pages 140-142; American Journal of Science and Arts, 3rd series, Vol. XVI, 1878, pages 216-217.

[9] For references see: Geol. Sur. of Ohio, Bull. 23, page 154; Bull. 31, pages 52-53.

ALLENSVILLE CONGLOMERATE

The Allensville conglomerate, named by Hyde for the village of Allensville in western Vinton County, is the third unit in the Logan series of the Mississippian system. It is quite distinctive in that it is a fine but very even-grained conglomerate, in size about like wheat grains. It may occur in one or in two distinct beds in sandstone and siliceous shale of the ordinary Waverly types. In thickness the conglomerate zones vary from one inch to four feet and that of the entire member from 2 to 25 feet. The Allensville formation is recognized along the outcrop from Scioto to Summit County. If present in larger quantities the well sorted Allensville conglomerate would be useful for several purposes.[10]

VINTON SANDSTONE

The youngest deposits in the Waverly group of rocks of Mississippian age are those of the Vinton formation which was named by Hyde for exposures in the western part of Vinton County. In this area it is made up of a series of sandstones and shales, but elsewhere it may vary from massive sandstones with little or no shale to shales with only thin lenses of sandstone. The sandstones, commonly, are fine grained, thin to massive bedded and gray to drab in color. The thickness of the formation varies from 5 to 180 feet, depending on the amount left by the erosion cycle at the close of Mississippian time. Under deep covering in eastern Ohio the Vinton sandstone becomes the Keener sand of the driller and is very important as a source of petroleum and natural gas in Jefferson, Belmont, Monroe, Harrison, Washington, Noble and Morgan counties. It also contains brine but so far this has not been utilized for commercial purposes.

PENNSYLVANIAN SYSTEM

The great group of rocks now placed in the Pennsylvanian system was first defined, in 1838, in Pennsylvania, by Henry D. Rogers in work done for the United States Government. It has been and is of enormous importance in the Appalachian field for its coals, clays, shales, sandstones, limestones, iron ore, petroleum, natural gas and brines. Throughout this field Pennsylvanian rocks cover an area of more than 70,800 square miles in central and western Pennsylvania, eastern Ohio, western Maryland, western Virginia, West Virginia, eastern Kentucky, eastern Tennessee and northern Alabama. In Ohio such strata are found over an area of approximately 12,340 square miles. The Pennsylvanian system is sub-divided into four series, Pottsville, Allegheny, Conemaugh and Monongahela.

POTTSVILLE SERIES

The Pottsville is the basal series of the Pennsylvanian system and is of vast importance for its mineral resources. The total area of such rocks appearing at the surface in Ohio is not far from 3,760 square miles. It extends over parts or all of Trumbull, Mahoning, Geauga, Cuyahoga, Medina, Summit, Portage, Wayne, Stark, Holmes, Tuscarawas, Knox, Coshocton, Licking, Muskingum, Perry, Fairfield, Hocking, Vinton, Pike, Jackson, Scioto and Lawrence Counties. This formation averages about 255 feet in thickness but varies, on account of disconformities, between 175 and 400 feet. The Pottsville series comprises all the strata from the Mississippian rocks to the base of the Brookville coal. The recognized and named strata include 12 coal beds, 13 clays, 7 iron ores, 12 sandstones, 1 conglomerate and numerous shales. Here only the Sharon conglomerate and the Massillon and Homewood sandstones need be considered as of more than ordinary interest.

---

[10] See references: Geol. Sur. Ohio, Bull. 23, page 154; Bull. 31, pages 53–55.

SHARON CONGLOMERATE

The Sharon conglomerate at the base of the Pottsville series is one of the outstanding deposits of Ohio. It is of interest for its geological history, for its physiographic and scenic features, for the many uses to which it is applied and for its storage and yield of petroleum, natural gas, salt brine and rock water. The stone varies in composition from a medium-grained sandstone to a coarse pebbly conglomerate, very loosely cemented. The deposits always occupy broad, deep depressions, resembling erosion valleys, cut in the older Mississippian floor. The deposits are very erratic in distribution and vary from 10 to 250 feet in thickness. The pebbles are vein quartz with a high purity. They were derived from the Canadian granite and gneiss fields to the north and after passing through long cycles of weathering and transportation came to rest in great beds in Ohio and in areas in adjacent states. In southern Ohio the main fields are in eastern Scioto, eastern Pike and western Jackson Counties and in the northern part of the State in eastern Wayne, Stark, Mahoning, southern Trumbull, Portage, Summit, eastern Medina, southeastern Cuyahoga and Geauga Counties.

The Sharon conglomerate is the Maxton sand of the driller and in southeastern Ohio yields petroleum and natural gas, also brine of fair strength. Where present in good development along the outcrop it is an excellent source for rock water and for springs, some unusual. It provides also much scenic beauty in both southern and northern Ohio such as Rock Run, White's Gulch, Canter's Cave, Big Rock, Nelson Ledges, Thompson Ledges, Boston Ledges, Cuyahoga Falls and Little Mountain. The Sharon conglomerate is of economic importance for the manufacture of silica brick, for reduction to the metal silicon, for pebble aggregate for nitrating plants, for paper, stucco work and sand blasting. Some glass and foundry sand are produced from selected material. Locally it is used for road facing, concrete work and railroad ballast.

MASSILLON SANDSTONE

The Massillon sandstone extends with some wants across the State from Youngstown in Mahoning County to the Ohio River in eastern Scioto County. It forms prominent exposures in Scioto, Jackson, Vinton, Hocking, Perry, Muskingum, Coshocton, Holmes, Wayne, Stark and Mahoning Counties. Stratigraphically the position of the Massillon sandstone is in the lower part of the Pottsville series, not far above the Quakertown coal. The thickness of the formation varies from 5 to 60 feet but the general measurement is between 20 and 45 feet. This member is usually massive in character, being broken by few bedding planes of sharp definition. Commonly it is conspicuously cross bedded, indicating its origin in shallow water with movement as along seashores. In texture it varies from a fine grained sandstone to one quite coarse or pebbly. The stone normally is light gray in color but through weathering it attains shades of drab, pink, brown and even variegated. Locally the Massillon sandstone is used in a large way for building stone for both light and heavy masonry. It is suitable also for glass sand, core sand, abrasives, etc. Under shallow covering it yields excellent supplies of water both for farm and home consumption and for industrial purposes. The Massillon correlates with the First Salt Sand of the driller and under deep covering in southeastern Ohio yields petroleum, natural gas and brine.

HOMEWOOD SANDSTONE

The Homewood sandstone is erratically developed along the line of outcrop across the state from Mahoning County on the east to Scioto and Lawrence Counties on the south. Its stratigraphic position is best defined as lying between the Upper Mercer and the Putnam Hill limestones, not uncommonly filling most of the interval The thickness of the member varies from 5 to 60 feet. Where well developed this sandstone occurs in massive ledges broken by irregular and widely spaced bedding planes and by vertical joints. It is somewhat cross-bedded, but shows little tendency to part, on weathering, along these planes. The Homewood is commonly a fine-textured sandstone. It is composed in the main of well rounded quartz grains admixed with a noticeable quantity of mica flakes. The bonding components are iron oxides and clay matter. The normal color of the stone is rather pleasing, ranging from light gray to soft drab shales. In Ohio the Homewood sandstone has been worked most largely around Zanesville where it was employed for years for foundations, retaining walls, culverts, steps, walks and house trimmings.

ALLEGHENY SERIES

The Allegheny series in Ohio is of special importance for its great clay beds and for its thick and persistent coals and is of some value for its iron ores, shales, sandstones and limestones. This series of rocks begins at the base of the Brookville coal and includes all the strata to the top of the Upper Freeport coal. The thickness of this section varies from 175 to 250 feet, but averages about 200 feet. The area of these rocks exposed at the outcrop is not far from 2,600 square miles. Sandstones, part shaly or fine in texture, constitute about 40 per cent of the total strata. In a general way the Allegheny series extends in a broad belt from Lawrence County on the Ohio River northward and eastward across Jackson, Vinton, Hocking, Perry, Athens, Muskingum, Coshocton, Tuscarawas, Stark and Jefferson Counties to Columbiana County on the Ohio-Pennsylvania state line. Small areas are also present in some of the adjoining counties. It contains a few sandstones of regional continuity which are of interest for their economic value These are Clarion or Hecla, Lower Freeport and Upper Freeport.

CLARION OR HECLA SANDSTONE

In Ohio the Clarion is one of the most prominent and persistent sandstones in the coal formations. It extends with some rather local wants from Columbiana County to Lawrence County. Where present such deposits take up most of the interval between the Putnam Hill limestone and the Clarion coal. The usual range in thickness is between 20 and 55 feet. The stone is massive in character, is somewhat marked by cross-bedding planes and varies from medium fine to coarse in texture. The color range is from nearly white to drab. The common cements are iron oxides and clay matter, the latter often predominating. Only locally, however, are the bonding components sufficiently strong and weather resistant for the stone to be satisfactory for building purposes. The Clarion sandstone has had a long and varied use. Formerly in Lawrence, Scioto, Jackson, Gallia, Vinton and Hocking Counties it was employed for building the stacks, linings and bridge walls of charcoal furnaces and for linings of ore kilns. In the Zanesville district the Clarion sandstone was used in the construction of some of the finest homes, for building canal locks, for foundations and for decorative work with brick masonry. Further, it supplies stone for various building purposes in Coshocton, Holmes and Tuscarawas Counties.

LOWER FREEPORT SANDSTONE

The Lower Freeport is far above the average coal formation sandstone in the continuity of the stratum across the state. It outcrops prominently in Columbiana, Carroll, Tuscarawas, Coshocton, Muskingum, Perry, Athens, Vinton, Jackson, Gallia and Lawrence Counties. Stratigraphically it is placed in the interval between the great Middle Kittanning coal and the Lower Freeport limestone. The deposits vary from 5 to 75 feet or more in thickness. The Lower Freeport sandstone is usually massive in character, more or less marked by cross-bedding planes, somewhat micaceous in mineral content and medium coarse but uniform in texture The freshly quarried stone varies in color from very light gray, through yellowish and drab to reddish brown, the shades depending largely on the state of oxidation of the iron components. The chief bonding material is iron oxide in the limonite form. In Ohio the Lower Freeport sandstone was employed, as early as 1805, for building purposes by the pioneers of Columbiana County. At various places along the line of outcrop across the state it has served many purposes such as construction of houses, blast furnaces, mills and mill dams, carding mills, retaining walls, culverts, bridges, abutments and foundations.

UPPER FREEPORT SANDSTONE

The Upper Freeport sandstone belongs in the interval between the Lower Freeport coal and the Bolivar clay. It may be absent from the section, may fill only a part of the interval, may occupy all of this space or may expand so that it replaces overlying or underlying beds. It is usually a loosely bonded, medium-grained sandstone, decidedly micaceous and somewhat ferruginous in character. Clay matter also forms part of the bond. It is always cross-bedded, the planes being best marked on weathered surfaces. The color of the rock varies from light gray to brownish buff, the intensity of the shade depending on the quantity of the iron components present and on the degree of weathering. This stratum varies in thickness from 1 to 60 feet. The Upper Freeport sandstone is locally developed from the Ohio River in Lawrence County, across western Gallia, eastern Vinton, western Athens, eastern Perry, central Muskingum, northwestern Guernsey, southeastern Tuscarawas, northwestern Carroll and central Columbiana County to the Ohio-Pennsylvania state line. This formation has been utilized for common building purposes in local areas, for pulpstones in Jefferson County and for molding sand in Muskingum and Perry Counties.

CONEMAUGH SERIES

The third division of the Pennsylvanian system is the Conemaugh series which embraces all the rocks between the top of Upper Freeport coal and the base of the Pittsburgh coal and which includes shales, limestones, sandstones, coals, clays, and nodular iron ores. The thickness of this rock section varies from 340 to 500 feet but the average measurement is close to 400 feet. Conemaugh rocks are exposed in the southeastern part of the State in a broad belt varying from 10 to 20 miles in width and extending from the Ohio River in Lawrence County to the Ohio-Pennsylvania line in Columbiana County. The total area of such rocks exposed at the surface in Ohio is not far from 3,000 square miles. Some marine strata are present in the lower half of the series, the Ames limestone or the Skelley limestone being the highest known formations laid down in the sea. Above this horizon the strata are all of fresh water origin or are thus land laid deposits. Fresh water deposits are also present in the lower half of the Conemaugh series or below the Ames limestone. Sandstones form a prominent part of the entire sections. These are usually massive in character and locally well bonded by cementing compounds. The most prominent formations are the Lower Mahoning, Buffalo, Cow Run and Morgantown sandstones.

LOWER MAHONING SANDSTONE

The Lower Mahoning or as usually identified the "Mahoning" sandstone is found in the interval between the Upper Freeport coal and the Mahoning coal Usually where present it takes most of this interval but locally so thickens that it replaces the underlying or the overlying coal. The thickness of the formation varies from 5 to 50 feet, but the usual measurement falls between 15 and 35 feet. Texturally it changes from a fine-grained to a coarse-grained or even to a conglomeratic sandstone. The pebbles, which are of milky quartz and commonly not more than one-fourth inch in diameter, are for the most part confined to the basal portion of the deposits The Mahoning sandstone is commonly cross-bedded. In places this physical feature is prominently developed. Great variation is also shown in the hardness and in the weather resistance of the material. In general it is poorly cemented and crumbles readily on exposure to the elements. The coarse-grained rock is often more firmly bonded, as shown by resistant blocks strewn along the outcrop and by conspicuous ledges projecting from the hillsides. This sandstone is locally well developed in Columbiana, Carroll, Harrison, Guernsey, Muskingum and Lawrence Counties. It has been quarried for the trade in Harrison County and utilized locally in other places.

BUFFALO SANDSTONE

The Buffalo sandstone is placed a few feet below the Cambridge limestone and not far above the Brush Creek limestone or fossiliferous block shale. The deposits are local in distribution, being best developed along Stillwater Creek in Tuscarawas County, near Sherrodsville in Carroll County and along Leading Creek in Meigs County. The thickness of the member not often exceeds 30 feet. Where well developed the stone is massive in character, coarse to pebbly in texture and gray to buff in color. It weathers well, becoming darker through exposure. The Buffalo sandstone has been quarried in a large way at a few places for stone for houses, churches, schools and heavy masonry. Under deep covering it becomes the Buell Run sand of the driller and yields petroleum, natural gas and brine.

COW RUN SANDSTONE

The Cow Run sandstone is of local development in Ohio It is well represented by exposures along the Muskingum River in Muskingum and Morgan Counties. Stratigraphically the member lies on or only a few feet above the Anderson coal and on the average about 45 feet below the Ames limestone. The thickness of the member varies from 5 to 40 feet, but averages about 20 feet. It is coarse grained, loosely cemented, light gray to drab in color and without definite partings or bedding planes Along the Muskingum River in southern Muskingum and northern Morgan Counties the Cow Run sandstone was quarried in a large way for shipment and for local use. The chief purposes for which it was utilized were canal locks, bridge piers, abutments, culverts, dams, foundations and retaining walls. To a less extent it was employed for steps, caps, sills, chimneys, fireplaces, cellars and spring houses. The Cow Run is also one of the great sands of the oil driller and very important in Morgan, Washington, Noble and Athens Counties.

MORGANTOWN SANDSTONE

The Morgantown sandstone is well described by Condit:[11] "Like all the sandstones of the Conemaugh, this bed is very irregular in its occurrence, being conspicuous in one place and entirely wanting a short distance away. The rock varies from a fine-grained, bluish gray freestone, similar to the Berea at Cleveland, to a coarse-grained, massive, yellowish gray bed 30 feet or more in thickness Where present in massive form, the Morgantown sandstone is seldom separated from the underlying Ames fossiliferous limestone by more than 25 feet of shale, and often the interval is only 10 to 15 feet. This stratum is found over much of the eastern part of Ohio, where geologically due, and varies in thickness from 15 to 30 feet. The greatest thickness in eastern Ohio is probably in southeastern Carroll County and in the adjacent parts of Harrison. It is also well developed locally in Muskingum, Morgan, Athens, Meigs and Gallia Counties." It provides many farms and villages along and near its outcrop with a satisfactory water supply and is the Wolf Creek sand of the oil driller.

---

[11] Geol. Survey of Ohio, Bull. 17, pages 25–26.

MONONGAHELA SERIES

The Monongahela series in Ohio is confined to a belt varying from 5 to 40 miles in width and bordering the Ohio River or not far back from this stream from northern Jefferson County to southern Lawrence County. Rocks belonging to this series are found in eastern Lawrence, eastern Gallia, Meigs, eastern Athens, Washington, Morgan, southeastern Muskingum, Noble, Monroe, southern Guernsey, Belmont, eastern Harrison and Jefferson Counties. The area of outcrop is about 1,213 square miles and the total area in Ohio, with the overlying Permian, is approximately 2,980 square miles. The general thickness of the series varies from 235 to 263 feet but averages 248 feet. This section begins at the base of the Pittsburgh coal and ends at the top of the Waynesburg coal. It is made up mainly of shales, fresh-water limestones and sandstones, but it also contains coals, clays and nodular iron ores. Few of the sandstones are persistent over wide areas, the chief ones are Lower Sewickley, Upper Sewickley and Uniontown. In general these sandstones lack purity and are not weather-resistant, hence they have been of little economic value. The most important is the Upper Sewickley.

UPPER SEWICKLEY SANDSTONE

The Upper Sewickley sandstone is present only in local areas along the western and southern margins of the Monongahela field of rocks in Ohio. This member is best represented in eastern Noble, north central Washington, southeastern Muskingum and southern Meigs counties Such deposits usually expand or contract erratically and suddenly between the limits of 1 and 70 feet. The Upper Sewickley sandstone is not distinctive in texture, in structure or in composition from other sandstone in the upper part of the Pennsylvanian system. Only locally is it sufficiently well bonded for building stone and heavy masonry. It has been utilized to a small extent near Pomeroy in Meigs County and along Duck Creek in Noble and Washington Counties. It is the Goose Run sand of the oil driller, locally providing small fields. Where present along the outcrop it performs a service for a water supply to farms and villages.

PERMIAN SYSTEM

DUNKARD SERIES

The Dunkard series of rocks in Ohio is confined to a narrow belt bordering the Ohio River and extending from southern Jefferson County across Belmont, Monroe, Washington and Athens Counties to southern Meigs County. Small outlying tracts are also present in southern Noble and eastern Morgan Counties. The total area is not far from 1,767 square miles. The maximum thickness of this series of rocks in Ohio is approximately 626 feet. It includes sandstones, shales, limestones in quantity and clays and coals in thin beds. The sandstones recognized geologically are; in ascending order, Waynesburg, Mannington, Lower Marietta, Upper Marietta, Hundred, Jollytown, Fish Creek, Nineveh and Gilmore. These make up nearly 45 per cent of the total section. Such sandstones have been used in a large way for the grindstone and pulpstone industry in the Marietta district. Of these the ones of most importance are the Upper Marietta and the Hundred.

UPPER MARIETTA SANDSTONE

This sandstone came into prominence for its use in the manufacture of grindstones and pulpstones. It is described by Stauffer and Schroyer as follows:[12] "This is an exceedingly massive sandstone showing rather indistinct lamination which occasionally is very pronounced. It is a medium grained sandstone which at places becomes very coarse. On fresh exposures the color is gray, but it weathers to a buff or even a brownish color. This is the chief grindstone horizon of the Marietta region and the rock was named by I. C. White from the outcrop and numerous quarries in it in the vicinity of that city."

---

[12] Geol. Sur. of Ohio, Fourth Series, Bull. 22, page 20.

HUNDRED SANDSTONE

The Hundred is one of the conspicuous sandstones in the Washington formation of the Dunkard series. Its area of outcrop is small and is largely confined to the deep Parkersburg-Lorain syncline in the western part of Washington County. The description given by Stauffer and Schroyer follows:[13] "The Hundred sandstone as it occurs in Ohio is a coarse massive rock made up of sharp quartz grains rather well cemented with lime. The lower half of the deposit is likely to contain quartz pebbles, and sometimes they are abundant and rather large. Ripple marks are common and the mud covered surfaces of some layers show well developed sun cracks. Light-colored mica, probably muscovite, is distributed throughout, but the dark micas are rare. Hard brown masses of boulder-like shape occur in the upper part of this sandstone in the vicinity of Marietta and have probably been formed by the deposition of an excess of iron which in such spots acts as the chief cement. It is one of the sandstones used in the manufacture of grindstones in Ohio where its horizon is 140 feet below the Nineveh limestone."

USES OF SANDSTONES, CONGLOMERATES AND SANDS

- Sandstone for abrasive purposes:
  - Grindstones.
  - Pulpstones for grinding paper pulp.
  - Wheels for grinding tan bark (pioneer days).
  - Whetstones.
  - Rubbing stones.
  - Buhr-stones (Peninsula Quarry, pioneer days).
  - Millstones, chasers and dragstones.
  - Stones for grinding paint pigments (pioneer days).
- Sand for abrasive uses:
  - Sandpaper and sand belts.
  - Sand blasting.
  - Scouring powers and pastes.
  - Buffing compounds.
  - Soaps and detergents.
  - Frosting glass.
  - Stone and marble polishing.
  - Sawing stone with blade or wire.
  - Cleaning by tumbling.
- Sand for railroad use:
  - Sanding rails of steam railroads.
  - Sanding rails of electric railroads.
- Sand for filtering purposes:
  - Municipal water purification.
  - Industrial water purification.
  - Household water purification.
  - Oil refining.
- Sand for foundry purposes:
  - Molding sand for iron, steel, brass, bronze, aluminum, Dow-metal, etc.
  - Core sand.
  - Opening and parting sand.
  - Finely ground sand for foundry mold wash.
- Sand for ceramic uses:
  - Potters flint for china and porcelain bodies and for glazes and enamels.
  - Setting and packing saggers
  - Sanding brick in setting.
  - Sanding molds in common brick making.
  - As component in sand-lime brick.
  - Sand and clay mixtures for kiln daubing.
- Sandstone for refractory purposes:
  - Hearths and linings of charcoal furnaces (pioneer days).
  - Walls of charcoal furnaces.
  - Lining hearths of forges (pioneer days).
  - Lining Bessemer converters (ganister used).
  - Lining of cupolas.
  - Lining of lime kilns (not common).
  - Lining of ore-roasting kilns (pioneer days).
  - Lining brick kilns (pioneer days).
  - Hearths and chimneys of homes.
  - Lining baking ovens (pioneer days).
  - Sandstone base for kettle in tar making (pioneer days).

---

[13] Geol. Sur., Ohio, Fourth Series, Bull. 22, pages 20 and 21.

Sand for refractory purposes:
- Packing walls of charcoal furnaces (pioneer days).
- Pig beds at blast furnaces.
- Slag runners at blast furnaces.

Uses of sandstone formations under deep covering:
- Accumulation of petroleum.
- Accumulation of natural gas.
- Storage of natural and artificial gas.
- Source for brine
- Source of potable water.

Various uses of conglomerates or pebbles therefrom:
- Pebbles for reduction to the metal silicon
- Pebbles for tar roofing.
- Pebbles for chicken grit.
- Pebbles for greenhouse purposes.
- Pebbles for facing concrete blocks.
- Pebbles for facing stucco walls.
- Pebbles for nitrating beds in sewage disposal plants.
- Conglomerate for manufacture of silica brick.
- Conglomerate for roads and driveways
- Conglomerate for walks and terraces.
- Conglomerates for sand blasting.
- Conglomerates for railroad ballast.
- Conglomerates for concrete.
- Conglomerate stone for decorative effects in walls, chimneys, gardens, etc

Sand used in building materials:
- Mortars.
- Plasters.
- Cement mixtures.
- Asbestos shingles and tiles
- Mastic for walls, joints, etc.
- Asphalt paving mixtures.
- Composition flooring.
- Gypsum plaster combinations.
- To keep rolled tar paper and shingles from sticking.

Sandstone for construction purposes:
- Mill dams.
- Mills and factories.
- Mill blocks.
- Canal locks and aqueducts.
- Bridges
- Bridge and ice piers.
- Abutments
- Arches.
- Culverts.
- Retaining walls.
- Riprap.
- Breakwater stone.
- Railroad ballast.
- Road stone.
- Paving block.
- Rubble stone
- Building stone, facing, sills, lintels, etc.
- Foundations.
- Underpinnings
- Platforms.
- Steps.
- Walks and sidewalks.
- Flagging.
- Curbing.
- Burial vaults.
- Tombstones
- Mausoleums.
- Base of monuments.
- Burial lot markers.
- Stone fences.
- Stone fence posts.

Silica for chemical uses:
- Component for cements
- Component of certain slags.
- Sodium silicate manufacture
- Silicon carbide (carborundum) manufacture.
- Control of clinker in coal.
- Silicon tetrachloride for use in screening vessels.
- Silica acid, silica gel, for an absorbent.
- Silicon tetramethyl, $Si(CH_2)_4$ for chemical uses.
- Silicontetra ethyl Si $(C_2H_5)_4$ for chemical uses.

Finely ground sand:
- Body in paints
- Antioxidants.
- Cosmetics and dentifrices.
- Filler in rubber.
- Wood filler.

Other uses:
- Sand for standard cement testing.
- Sand for chemical laboratory use.
- Sand for sanding roads when icy.
- Sand for foundations of pavements.
- Sand for filler of fertilizers.
- Sand for bedding in stock cars.
- Sand for use by blacksmiths in welding iron and steel.
- Sand for use in mechanical toys.

A NEW GENUS MEXICANANUS AND SPECIES OF LEAFHOPPER FROM MEXICO RELATED TO PHLEPSIUS AND TEXANANUS

DWIGHT M. DeLONG,
Department of Zoology and Entomology,
Ohio State University

Most of the Mexican species of this general group seem to fit rather definitely into one of the two described genera Phlepsius and Texananus which contain the species of the "Phlepsius" group found in the United States and Canada. The species described at this time seems to have some characters found in each of these genera and a new genus is being erected for its inclusion

Genus **Mexicananus** nov.

Vertex narrow, produced, bluntly angled, decidedly more produced and pointed than in the short round-headed species of the *costomaculatus* group. The pronotum is broader than the vertex, the humeral angles being strongly produced and angled. Body narrow, elongate, gradually tapering to a narrow apex. Elytra long and narrow. Venation of elytra and color markings resembling those of *costomaculatus*. The wider pronotum shows a relationship to *Texananus*, the produced pointed vertex is more like the species of Phlepsius and the superficial appearance of *costomaculatus* indicates a close relationship to that portion of the Phlepsius genus. Genotype, *Mexicananus levis*, n sp

Mexicananus levis, n sp.

Superficially resembling *costomaculatus* but with a more produced angled vertex and with vertex narrower than the pronotum Length, female, 8 mm

Vertex produced and bluntly angled, more than half as long as basal width between the eyes. Humeral angles of pronotum extending beyond the eyes Elytra long and narrow.

Color: Vertex pale with a short oblique orange dash extending from apex toward inner basal margin of each eye. A brown spot on margin next each ocellus, and another on base about half way on either side of middle. Pronotum with an irregular longitudinal brown stripe extending from spots on base of vertex A shorter brown mark behind each eye on disc of pronotum. Scutellum with a small black spot on each side of apex. Elytra pale, subhyaline, except for the four brown spots where the veins unite with the costa. An irregular brown longitudinal stripe extends from this basal spot to middle of apex of elytron. Claval area with faint markings. Face below antennae with dark brown arcs.

Genitalia: Female last ventral segment about twice as long as preceding segment, posterior margin truncate.

Holotype female collected at Finca Vergel, Valley of the Rio Huixtla in Chiapas, Mexico, (elev., 2600 ft), May 23, 1935, by Dr Alfonse Dampf.

NEW COLEOPTERA WITH NOTES

(BUPRESTIDAE AND CERAMBYCIDAE)

JOSEF N. KNULL,
The Ohio State University, Department of Zoology and Entomology
Columbus, Ohio

Dicerca querci cajonensis n. subsp.

Female.—This subspecies differs from *D. querci* Knull in the following ways: Pronotum with sides subparallel on basal two-thirds, then acutely rounded to apex. In *D. querci* Knull they are expanded in front of middle, surface more finely confluently punctate. Elytra more finely confluently punctate, smooth callosities less numerous. Last visible abdominal sternite less acute, apex sinuate each side of median lobe, acutely rounded in the species. Posterior coxal plate lacking prominent tooth on margin.

Length 20.5 mm.; width 8.5 mm.

Holotype female in writer's collection taken on oak at Cajon Pass, Cal., June 8, 1940, by D. J. & J. N. Knull.

Taphrocerus huachucanus n. sp.

Male.—Form elongate; dark shining bronze throughout; irregular short pubescence forming an indistinct design, a transverse patch on basal fourth, a narrower transverse patch back of middle extending forward in middle of each elytron and as apical transverse patch.

Head convex, front slightly concave, median depression slight; surface densely finely punctate, punctures lighter and less numerous on vertex, pubescence becoming very dense on front.

Pronotum wider than long, widest at base, sides deflected in front; disk convex, with transverse basal depression and strong lateral depression on each side; surface punctate, more numerous on all four sides, each puncture bearing an appressed white hair. Scutellum triangular impunctate.

Elytra wider than base of pronotum; sides constricted back of humeral angles, expanded back of middle, then oblique to obtusely rounded apices, apices serrulate on outer edge; disk flattened, a fine sinuate carina running parallel to outer margin, a humeral depression each side; surface densely coarsely punctured, punctures arranged in irregular rows becoming smaller posteriorly.

Ventral surface with well separated large shallow oval punctures.

Length 3.4 mm.; width 1.2 mm.

Female.—Differs from male by the lack of dense pubescence on front.

Holotype male and allotype collected in Huachuca Mts., Ariz., September 9, 1938, by D. J. & J. N. Knull. Paratypes from Arizona: Huachuca Mts., above date and July 20, August 18; Patagonia Mts., July 20; Williams, July 9, and Oak Creek Can., August 15, all D. J. & J. N. Knull. Huachuca Mts., July 28, J. S. Hine; Sierra Ancha Mts., D. K. Duncan; Ruby, July 13; Arivaca, July 20; Huachuca Mts., July 9, all R. H. Beamer, last locality and date D. E. Hardy; Oak Creek Can., August, 6000 ft., F. H. Snow. New Mexico: Silver City, July 22 and Ruidoso, June 26, R. H. Beamer.

Holotype, allotype and paratypes in writer's collection; paratypes in University of Kansas and The Ohio State University collections.

This species can be separated from eastern species of the *T. gracilis* (Say) complex by being bronze in color, more coarsely punctured elytra, and by structure of male genitalia.

A study of the male genitalia of specimens formerly grouped under *T. gracilis* (Say) shows considerable difference in form and more than one species will have to be recognized. Just what names to apply to the species is a question since the types of the described forms are not available for study. The accompanying figures will show the differences in male genitalia.

Taphrocerus nicolayi Obenb.

I consider this to be the small form which we have frequently confused with *T. gracilis* (Say), although the male genitalia of the two are identical and distribution records agree. Dr. Obenberger[1] points out the differences in the two species.

Taphrocerus howardi Obenb.

I consider this to be the form frequently confused with *T. gracilis* (Say). Specimens are at hand from Florida, Brownsville, Texas, and Vienna, Illinois.

Taphrocerus schaefferi N. & W.

This species has a wide distribution and is frequently confused with rubbed specimens of *T. gracilis* (Say). Material is at hand from Texas, Pennsylvania, Illinois and Ohio.

Taphrocerus agrilloides Cr.

Specimens of this southern species have been taken in Cedar Swamp, Champaign County, Ohio, July and October. This is interesting for arbor vitae (*Thuja occidentalis* L.) grows in the same habitat.

Rhopalophora prorubra n. sp.

Head, prothorax, scutellum, mesosternum and middle coxae red, rest of insect black. Head and pronotum shining.

Head convex; surface densely punctured on front, lightly transversely rugose on vertex, pubescence short, inconspicuous; antennae eleven-jointed, over two joints extending beyond apices of elytra, scape stout, second joint as broad as long, third longer than fourth, fifth longer than third, sixth longer than fifth, joints seven and eight equal, nine and ten diminishing in length, eleventh longer than tenth.

Pronotum longer than wide, widest back of middle, wider at base than at apex; sides broadly rounded with a slight constriction in front of middle and near base; disk convex with faint trace of tubercles each side at middle, base and on side; surface sparsely punctate, punctures small, pubescence inconspicuous. Scutellum small.

Elytra at base wider than pronotum; sides sinuate back of humeri, parallel to apical sixth; then broadly rounded to truncate apices, serrulate from middle; disk flat; surface very coarsely punctured, punctures separated by less than their own diameters, pubescence conspicuous in scutellar region only.

Abdomen beneath finely punctate, pubescence short, dense. Prosternum finely transversely rugose.

Length 6.4 mm.; width 1.4 mm.

Described from one specimen in the collection of writer collected by him on flowers in Sabino Canyon, Santa Catalina Mts., Ariz., August 13, 1936.

This species somewhat resembles *R. angustatus* Schffr. However, it can be separated by its shorter, more robust form, black elytra, and lack of marked pubescence on dorsal surface.

Oxoplus tumacacorii n. sp.

Female.—Form short, robust; opaque, abdomen shining. Prothorax, part of elytra and abdomen red; head, antennae, apical and basal margins of pronotum, scutellum, greater part of elytra, apical and basal margins of prosternum, ventral portions of meso- and metathorax and legs black.

Head confluently punctate, vertex transversely strigate, surface densely pubescent; antennae eleven-jointed, slender, reaching end of elytra, scape stout, second joint as long as wide, third joint longest, fourth and fifth equal, each slightly shorter than third, sixth to eleventh gradually shorter, last joint sharply pointed at end, longer than tenth, joints six to eleven slightly serrate.

Pronotum one and one-half times as wide as long, constricted at base and apex, wider at base than at apex; sides strongly rounded, forming an obtuse tubercle at middle; surface convex, faint indications of one median and two lateral tubercles on each side, coarsely confluently punctured, golden, short pubescence dense, a few longer hairs each side. Scutellum triangular, produced into a sharp point posteriorly; surface densely punctured, punctures same size as on elytra.

---

[1] J. Obenberger, Sbornik entom. odd. Nár. Musea v. Praze., II–13, p. 70, 1924.

Elytra at base wider than widest part of pronotum; sides subparallel, broadly rounded on apical fourth, apices sinuately truncate, sutural margin produced into a short spine; surface densely punctate, punctures much smaller than on pronotum, of same size over entire surface, separated by less than their own diameters, short recumbent pubescence dense.

Abdomen beneath densely punctate, clothed with thin gray pubescence. Prosternum finely confluently punctate. Legs slender, coarsely punctate.

Length 15.5 mm.; width 4.8 mm.

Male.—Form more slender; elytra red with dark irregular stripe along suture extending from back of scutellum to apical fourth; beneath with pro- and mesosternum and posterior coxae black, abdomen and most of metasternum red. Antennae extending over three joints beyond elytral apices, last joint appendiculate, resembling a twelfth joint.

Holotype male in copulation with allotype and one male paratype taken in Tumacacori Mts., Ariz., August 24, 1940, by D. J. & J. N. Knull. One female paratype from Santa Rita Mts., Pima Co., Ariz., September 9, 1925, collected by C. T. Vorhies. Type material in writer's collection.

This species can be separated from *O. cruentus* Lec., its nearest ally, by its small form, more convex pronotum with more obtuse spine and markings of elytra.

Goes pulcher fuscatus n. var.

Male.—Slightly more slender than *G. pulcher* (Hald.). General background darker brown. Pubescence of head, antennae, thorax, scutellum, elytra, ventral surface and legs light gray. Transverse basal area darker, patch of pubescence back of middle lighter brown and apical area with darker brown pubescence.

Length 22 mm.; width 7 mm

Female.—Shorter antennae, color of background and pubescence agreeing with male.

Holotype male from McCurtain Co., Okla., June 27, A. Elred; allotype from Pine Valley, Okla., July, 1938, L. G. Duck, in writer's collection.

The varietal name is proposed for a form looking quite different from *G. pulcher* (Hald.) and occurring out of the recorded range of this species.

Anoplium simile Schffr.

Reared from dead inflorescence stem of yucca collected in the Chiricahua Mts., Ariz.

Schizax senex Lec.

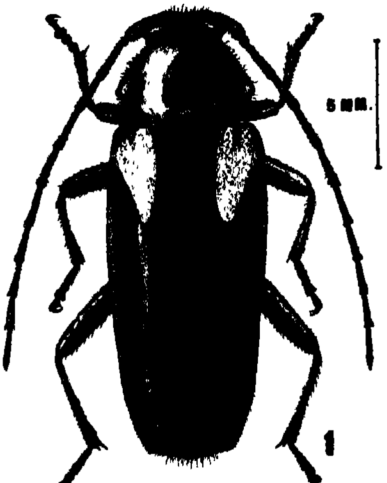
Specimens were reared from six-inch cut branches of hackberry (*Celtis reticulata* Torr.) from Oak Creek Canyon, Ariz. Larvae of *Chariessa elegans* Horn were feeding on the *Schizax* larvae.

Psapharochrus quadrigibbus (Say)

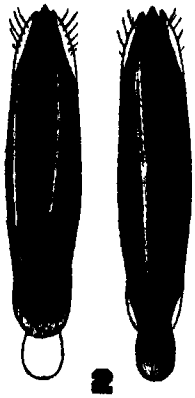
Adults were collected from mesquite at Brownsville, Texas, May 7 to June 1. These specimens are much lighter in color and the white markings on the elytra are somewhat darker than in our eastern material.

EXPLANATION OF PLATE

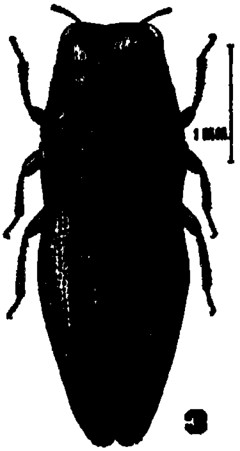
1. Female *Oxoplus tumacacorii* n. sp.
2. Male genitalia of *Taphrocerus gracilis* (Say). Dorsal view on left.
3. Male *Taphrocerus huachucanus* n. sp.
4. Male genitalia of *Taphrocerus huachucanus* n. sp.
5. Male genitalia of *Taphrocerus howardi* Obenb.
6. Male genitalia of *Taphrocerus schaefferi* N. & W.
7. *Rhopalophora prorubra* n. sp.
8. Female *Dicerca querci cajonensis* n. subsp.



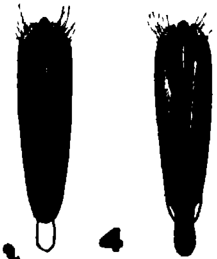
1



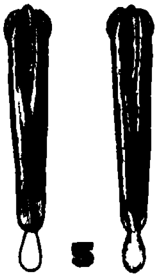
2



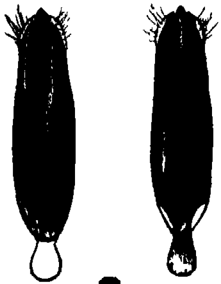
3



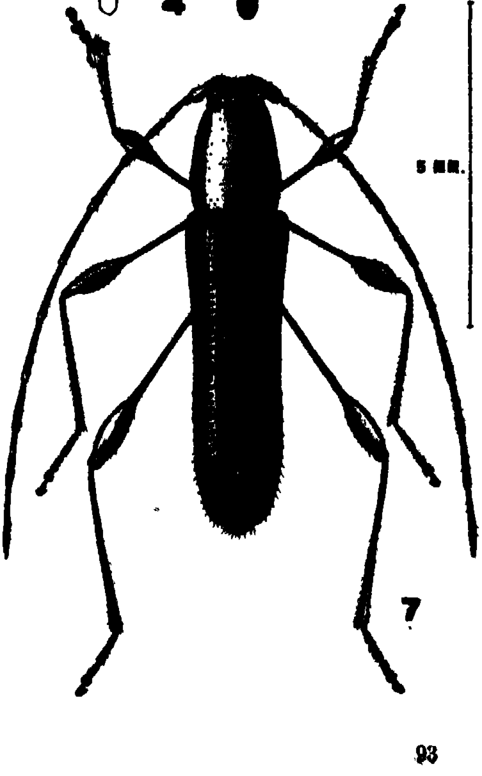
4



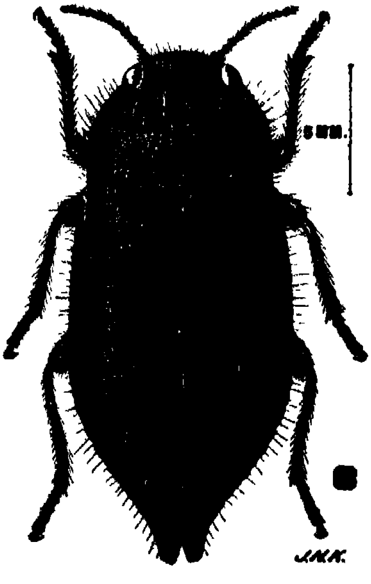
5



6



7



8

FURTHER STUDIES ON DISTRIBUTION AND TAXONOMY OF OHIO CRAYFISHES, AND THE DESCRIPTION OF A NEW SUBSPECIES

RENDELL RHOADES,
Ohio Division of Conservation and Natural Resources,
Wilmington College,
Wilmington, Ohio

The first reference to Ohio crayfishes of which I am aware was made by Girard (1852: 88) Other references followed until by 1870 Hagen was able to include in his monograph several records from southeastern and central Ohio. About 1880 Faxon collected material from the Little Miami River during his visit to Antioch College, Yellow Springs, Ohio. Near the turn of the century, Osburn and Williamson (1898: 21) and Williamson (1899: 47–48) collected crayfishes in many Ohio localities, and in recording their collections laid the foundation of the study of Ohio crayfishes. During 1920–1921 the Ohio Survey Party collected widely in Ohio and from the collections Turner (1926) published a well annotated list of thirteen species and subspecies This is the most complete publication on Ohio crayfishes to date.

The present paper is intended as a supplement to Turner's work. In it are described a new subspecies from Ohio, *Cambarus bartoni sciotensis;* a species and a subspecies are added to the state list; and the distribution of several other species more clearly defined through the addition of about fifteen hundred new records. In this paper only the counties from which Turner has not recorded a species are given. The total number of crayfishes now known to occur in Ohio is seventeen.

Discussion of Species

Procambarus blandingi acutus (Girard) (1852)
Cambarus (Cambarus) blandingii acutus Girard

Additional county records: Allen, Auglaize, Delaware, Hardin, Huron, Marion.

The species has been reported to me from Richland and Ashland counties by Mr. Fred Locke who gave an unmistakable description. However, the Ashland College Biology Department survey under the direction of Mrs Mary Auten Trautman failed to disclose the presence of the species in that county.

Orconectes sloani (Bundy) (1876)

There have been no significant additions to the distribution of this species since my paper (Rhoades, 1941: 93–98), except that it has been found common in Clear Creek and its spring-fed tributaries east of the Great Miami River in Warren County.

Orconectes propinquus sanborni (Faxon) (1884)
Cambarus (Faxonius) proquinquus sanborni Faxon

Additional county records: Adams, Ashtabula (U. S. N. M.), (Carnegie Mus.), Carroll (Carnegie Mus.), Clermont, Hamilton, Highland, Holmes, Jackson, Meigs, Ottawa, Pike, Richland, Ross, Starke (Carnegie Mus.), (U. S. N. M.), Trumbull (Mus. Zool., Univ. Mich.), Washington.

The species is present in the Ohio River as far west as the mouth of the Little Miami River and it has become established in certain tributary streams on the unglaciated Cumberland Plateau west to Clermont County. Its western limit conforms more closely with the western edge of the exposed Devonian shales and sandstones than it does to drainage areas.

Orconectes rusticus rusticus (Girard) (1852)
Cambarus (Faxonius) rusticus Girard

Additional county records: Brown, Champaign, Clark, Clermont, Clinton, Crawford, Darke, Geauga, Hancock (Mus. Zool., Univ. Mich.), Hardin, Highland, Jackson, Lawrence, Miami, Ottawa (U. S. N. M.), Pike, Preble, Sandusky, Van Wert, Washington, Wyandot (U. S. N. M.).

The range of this species in the southern counties is overlapped by *O. p. sanborni* from the east, *O. juvenilis* from the south and *O. sloani* from the west. With the investigation of the northeastern counties the *rusticus* distribution becomes more widespread, extending into the western end of Lake Erie. It is logical, in light of its preference for a limestone habitat, that it should occur there. Records east of the western limit of the Devonian shale and sandstone formations in Ohio may be the result of introductions from our western Ohio state fish farms to "islands" of limestone in an area of silicious rock. Incidentally, successful introductions are apparently rather rare.

Orconectes juvenilis (Hagen) (1870)
Cambarus (Faxonius) juvenilis Hagen

Additional county records: Adams, Brown, Clermont, Hamilton.

This species is more widespread and abundant than Turner's two records indicate. It seldom occurs associated with other stream species, except in the Ohio River from the mouth of the Big Sandy River to the Falls of the Ohio.

C. juvenilis is indicative of a Cumberland River influence in southern Ohio. The degree of difference in specimens from the Cumberland River and the Big Sandy River is slight. The Big Sandy and the southern Ohio *juvenilis* are remarkably close in the length and width of the areola, the shape of the rostrum, the prominent median carina, and the markings of the chela. This has probably resulted from a direct path of migration northward from the Cumberland Mountains by way of the Big Sandy River and the Ohio. The life history is similar to that of other species of the southern Appalachians but unique among the Ohio crayfishes.

Orconectes virilis (Hagen) (1870)
Cambarus (Faxonius) virilis Hagen

Turner stated (1926: 176–177) that *O. virilis* occurs in the Great Miami drainage near Dayton and in Scioto County but thus far no specimens have been discovered to substantiate these records. The species is probably not present in southern Ohio since it requires an ecological situation more commonly found in northern streams. Undoubtedly, *virilis* will be found to occur in the extreme northeastern counties of the state as Turner has indicated.

Orconectes immunis immunis (Hagen) (1870)
Cambarus (Faxonius) immunis Hagen

Additional county records: Darke, Miami, Preble, Putnam, Van Wert.

Several specimens have been received from "Forty Acre Pond, Sec. 27, Noble Twp., Auglaize County" which have been tentatively assigned to the subspecies, *O. immunis spinirostris*, until the status of the species and subspecies is determined.

Cambarus bartoni sciotensis n. subsp.

Type Locality: Limestone Cliffs below O'Shaughnessy Dam, Scioto River, Sec. 3, Liberty Twp., Delaware County, Ohio. (3 m. I; 4 f., September 27, 1937, R. Rhoades, coll.).

The holotype, male, form I, the allotype, male, form II, and the allotype, female, are deposited in the United States National Museum. Paratypes, a male, form I, and a female, are deposited in the Ohio State Museum. Paratypes from the same locality are retained in my collection. Paratypes from "Leatherlips Riffle," Scioto River, Sec. 4, Concord Twp. and Scioto Twp., Delaware County, Ohio, are deposited in the Museum of Comparative Zoology.

Additional specimens have been examined from Fairfield, Franklin, Delaware, Pickaway, Ross, Scioto, and Union counties. Turner's records for *C. bartoni robustus* from the Scioto River should be included in this subspecies.

Differential Characters: *Cambarus bartoni sciotensis*, here described, is unlike *C. bartoni bartoni* by having more converging margins of the rostrum and a wider, longer areola. It is unlike *C. bartoni robustus* in lacking the prominent contraction above and below at the base of the immovable finger. The tip of the inner ramus of the male, form I, gonopod is bulbous and constricted into a minute rounded tip. *C. b. sciotensis* differs from *Cambarus montanus montanus* by having a much longer and slightly narrower areola and the chela and fingers are rather smooth.

This subspecies is intermediate between *C. m. montanus* of the Appalachians and the *C. b. robustus* of the St. Lawrence drainage. It is doubtful if its presence in the Scioto River indicates a path of migration.

Distribution and Ecology: This subspecies occurs in the larger streams of the Scioto River drainage where its habitat is the large, fast riffles and where it spends its entire life. In this respect it is unlike *C. b. bartoni* which inhabits small and medium sized streams, and the adults of which burrow when the stream becomes intermittent.

Cambarus bartoni bartoni (Fabricius) (1798)
Cambarus (Cambarus) bartoni (Fabricius)

Additional county records: Adams, Brown, Champaign, Clark, Clermont, Clinton, Columbiana, Darke, Fairfield (O. S. M.), Fayette, Gallia, Hamilton,[1] Highland, Hocking, Lawrence, Licking, Logan, Madison, Miami, Montgomery, Muskingum, Perry, Pickaway, Pike, Ross, Scioto, Vinton, Wayne.

This species is probably distributed throughout the counties of the Ohio River drainage and many of the counties of the Lake Erie drainage near the watershed. Ohio is on the northern limit of the distribution of this species and most Ohio specimens are not typical with specimens from the type locality in the vicinity of Philadelphia or from the accepted center of origin of the species in the southern Appalachians. The areola becomes progressingly longer and narrower toward the northeast. The length of the areola of Scioto County specimens is from 34 to 36 per cent of the total length of the carapace, and its width is from 11 to 20 per cent of its own length. Specimens from the Mad River drainage measure from 37 to 41 per cent and 9 to 15 per cent respectively. This variation is accompanied by a loss of acuteness of the armature of the chelipeds.

In addition, the Mad River specimens possess a plane, broad, quadrangular rostrum which sharply contracts into an abbreviated acumen. Occasional specimens appear to have a carinated rostrum. The chelae, having the spines and tubercles in normal positions, are broadly triangular and the fingers are widely gaping in old males. If we apply Ortmann's criteria for determining specialization among crayfishes, the Mad River drainage race seems to be the most specialized of the Ohio *C. b. bartoni.*

Cambarus bartoni laevis Faxon (1914)

This subspecies constitutes an addition to the list of crayfishes of Ohio. It has been collected recently in Brown, Butler, Clinton, Hamilton, Miami, Montgomery, Preble, and Warren counties.

C. bartoni laevis is found under a variety of conditions. It inhabits small intermittent streams where it burrows under pieces of stone for a short distance, and during drought may extend its burrows considerably to reach the water level. Toward the northern limit of its range it often burrows along the swampy margins of streams in calamus beds. It avoids cold brooks which compose the common habitat of *C. b. bartoni.*

C. b. laevis, which is usually lighter in color than *C. b. bartoni*, can be easily distinguished by the long, linear areola. The rostrum is somewhat shorter than in *bartoni* and the margins gently converge into a rather long acumen. The carapace is slightly depressed and nearly smooth with only a few large granules on the sides of the hepatic region. The inner tip of the male, form I, gonopod is more strongly recurved and distinctly separated from the outer tip. The annulus ventralis is not distinctly different from *C. b. bartoni* except that it is more circular in outline.

---

[1] Turner included one record from Hamilton County on Map 5 (p. 184), but failed to include the locality in his list of Ohio records (p. 185).

Cambarus ortmanni Williamson (1907)

In the collections of the Museum of Comparative Zoology there is a specimen (M. C. Z., No. 243) from "Cincinnati, Ohio," which Hagen (1870: 78–79) called *C. bartoni*. Faxon (1885: 64) referred to this specimen and attempted to establish its affinity with *Cambarus latimanus*. He later (1914: 394–395) assigned the specimen to *C. ortmanni*. The doubt concerning the validity of the label and the detail with which Williamson discussed the limited range of his species caused subsequent authors to disregard this record.

Recent collections of this species have been taken in Auglaize, Butler, Clinton, Hamilton, Preble, and Warren counties.

The species is a burrower like *Cambarus diogenes*, but unlike that species builds a low wide chimney. Williamson found his Wells County, Indiana, specimens on stream margins and this is its usual habitat niche in Ohio. It is found on the old canal beds which have become swampy and often occurs associated with *C. b. laevis*. In the metropolitan area of Cincinnati *C. ortmanni* persists commonly where the water table is close to the surface.

C. ortmanni is readily distinguished from the other cambarids of Ohio by the very high, subquadrangular cephalothorax and the depressed, reduced rostrum. The areola is slightly longer and narrower than in *C. b. laevis*. The gonopods of the male, form I, resemble more closely the members of the diogenes section. The annulus ventralis has a high posterior wall and is circular in outline. The abdomen is noticeably shorter than the cephalothorax.

Cambarus fodiens (Cottle) (1863)
Cambarus argillicola Faxon (1884)

Additional county records. Auglaize, Fulton, Mercer, Van Wert.

Turner's records for this species were mostly from the north-central counties. Mr. Clark has provided me with records from the four counties mentioned above. He has obtained the specimens from woodland pools in early spring.

Cambarus diogenes Girard (1852)
Cambarus (Cambarus) diogenes Girard

Additional county records: Brown, Butler, Champaign, Clark, Clinton, Clermont, Darke, Defiance (O. S. M.), Hamilton, Greene, Highland, Logan, Lucas (Mus. Zool., Univ. Mich.), Mercer, Miami, Pike, Preble, Shelby, Warren.

This species probably occurs in every county of Ohio as indicated by the widespread records now existing. Specimens from southwestern Ohio have a more lanceolate rostrum, characteristic of the western race of *C. diogenes*.

I can mention but a few of the many who have contributed to the collection which forms the basis of this paper. Mr. Clarence F. Clark, Fish Management Agent, Ohio Division of Conservation and Natural Resources, has provided me with many records from his own collections from northwestern Ohio. Mr. John Z. Pelton and Mr. Lee S. Roach, Fish Management Agents, Ohio Division of Conservation and Natural Resources, have permitted me to examine their numerous collections from southern Ohio.

I am indebted to Mr. Milton B. Trautman, Research Associate, Franz Theodore Stone Laboratory, for his patient and helpful assistance. I wish to thank Dr. T. H. Langlois, Chief, Bureau of Fish Management and Propagation, Ohio Division of Conservation and Natural Resources, and Mr. Edward S. Thomas, Curator of Natural History, Ohio State Museum, who have rendered valuable assistance in the preparation of this paper.

REFERENCES

Cottle, T. J. 1863. On the Two Species of (Astacus) Found in Upper Canada. The Canad. Journ. Ind., Sci., & Arts, new ser., 8 (45) 5: 216–219.

Faxon, Walter. 1885. A Revision of the Astacidae. Part 1. The Genus Cambarus and Astacus. Mem. Mus. Comp. Zool., 10 (4): 1–186, pls. 1–10.

1914. Notes on the Crayfishes in the United States National Museum and the Museum of Comparative Zoology with Descriptions of New Species and Subspecies to which is appended a Catalogue of the Known Species and Subspecies. Mem. Mus. Comp. Zool., 40 (8): 351–427, pls. 1–13.

Girard, Charles. 1852. A Revision of the North American Astaci, with Observations on their Habits and Geographical Distribution. Proc. Acad. Nat. Sci. Phila., 6: 87–91.

Hagen, Hermann A. 1870. Monograph of the North American Astacidae. Ill. Cat. Mus. Comp. Zool., No. 3: 1–109, pls. 1–11.

Hobbs, Horton H., Jr. 1942. A Generic Revision of the Crayfishes of the Subfamily Cambarinae (Decapoda, Astacidae), with the Description of a New Genus and Species. Amer. Midl. Nat., 28 (2): 334–357, 3 pls.

Osburn, R. C., and Williamson, E. B. 1898. The Crayfish of Ohio. 6th Ann. Rept. O. Acad. Sci., p. 21.

Rhoades, Rendell. 1941. The Distribution of *Cambarus sloani* Bundy, in Ohio. O. Journ. Sci., 41 (2): 93–98, 7 figs., 1 map.

Turner, C. L. 1926. The Crayfishes of Ohio. O. Biol. Sur, Bull. No. 13: 145–; 95, 51 figs., 6 maps.

Williamson, E. B. 1899. Notes on Ohio Astacidae. 7th Ann. Rept. O. Acad. Sci., pp. 47–48.

1907. Notes on the Crayfishes of Wells County, Indiana, with the Description of a New Species. 31st Ann. Rept. Dept. Geol. & Nat. Res. Ind. (for 1906), pp. 749–673, 1 pl.

College Physics

The author has done much to make the book interesting and clear: the brief historical backgrounds for various experiments and principles with an occasional anecdote help to clarify as well as make seem familiar these experiments and principles.

The use of simple numerical computations within the body of the text material to illustrate the principle being discussed is helpful; this serves to make the student feel familiar with material as well as to clear away any "small last doubts" about the meaning of text.

The inclusion of problems with answers and problems without answers with a clearly indicated correspondence between the two sets of problems is a direct way to train the student. Problem working becomes interesting and this characteristic gives a definite advantage to the book as a text.

The introduction of the chapters with practical everyday physical observations, which organizes for the student a kind of general experimental background for the results to be obtained in the chapter, formulate a purpose for reading the material in the chapters and makes the principles more acceptable.

The author has given special attention to the clarification of the usual pitfalls of students such as meaning of phrases "head of water," etc., and the distinguishing between "mass" and weight, etc.

The last four paragraphs above give characteristics of the text that are quite important for the avowed purpose of the text: to make the explanations in the book clear enough that the instructor may devote most of the classroom time to extensions and applications of text material. This makes a flexible text—i. e., the text may be used equally conveniently for premedical physics courses as for engineering physics courses—the classroom application would be different.

The selection of topics is fairly satisfactory and the topics have been arranged in a way that is not disjointed but quite convenient for making daily assignments cover a chapter at a time.

There are a few possible improvements that might be suggested: the diagrams would be clearer if the parts of the apparatus or figure shown bore names instead of letters, and if the diagrams were designated not only by a figure but also by a brief explanatory legend. More attention should be given to transformations between different systems of units.

The topic of elasticity is not given enough attention compared to that given to the subject of heat.—*Kenneth P. Yates.*

College Physics, Abridged, Revised Edition, by H. A. Perkins. Prentice-Hall, New York, **1943. $4.00.**

BOOK NOTICES

Steel in Action

This book attempts to present, in condensed form, a rather comprehensive survey of the field of ferrous materials. Among the subjects dealt with are the history of the use of iron and steel, the industrial development, the metallurgy and technology, the economic and political aspects, and many other phases of the subject including some speculation on the probable trends of future development.

The introductory chapter presents a spectacular picture of the ubiquity of steel and its great variety of uses, from such articles as hair pins to "sleek ocean liners." This is followed in the second chapter by a comprehensive historical chronicle of the iron and steel industries throughout the world from the earliest records to modern times. Of particular interest is the discussion of Biblical references to iron making, and legends regarding it in Egypt and Asia Minor during Biblical times. Excavations, including the tomb of Tut-ankh-amen, have yielded iron implements, and iron was apparently in use before 3000 B. C. The early history of iron for many countries, such as, India, China and the Roman Empire, including Spain, Belgium and Gaul, is presented. Later developments in Britain, Germany, Sweden and, in colonial times, our own country are discussed. Of particular interest are the descriptions of early manufacturing methods in this country. These descriptions include some data on prices and wages.

Under the chapter heading "Manufacture of Iron and Steel" are discussed first, the ores of iron with some reference to mining methods; secondly, the production of coke is surveyed, with a brief description of the by-products and some figures on yields of both coke and by-products. A condensed, but fairly complete description of the blast furnace, open hearth, Bessemer and electric furnaces is followed by a similar discussion of various rolling and finishing processes. The chapter is well supplied with illustrations and flow sheets.

A four page chapter entitled "Carbon Steel" is devoted almost entirely to a discussion of the effects of impurities in such steels.

The discussion of alloy steels includes descriptions of the various alloying elements, e. g., nickel, chromium, tungsten, etc., and their effects on physical properties, heat treatment and metallographic structures.

From here on, the author delves into fields which are apparently more to his personal interest. The book takes up the iron resources of the world and the constant political struggles to dominate these resources. The sources of the ores of iron and its alloying elements are listed in great detail as are also the materials that enter into the smelting and refining processes, such as, fireclay, limestone and magnesite. The subject of scrap, its importance in steel production and its relation to steel business trends are discussed. As the story develops the positions of the various countries with regard to wartime steel production and requirements is elaborately pictured and credit is given American industry for its rapid development in meeting these conditions. The story ends with a glittering picture of "things to come" in the postwar world.

The book contains material enough for at least two, much larger volumes. The chapter on the early history of steel alone could be expanded into a fascinating story. The four chapters devoted to manufacture and technology are too condensed to be of much value to anyone not already acquainted with the subject, and too elementary to be of much interest to the initiated. The latter half of the book, devoted to the economic and political aspects of steel, seems unconnected with what precedes.

Throughout the text the reader is presented with fact after fact in rapid succession but each statement emphasized with superlatives, apparently to the exclusion of all others. All details are included. The author seems unwilling to omit or relegate to tables any of the items of production, consumption or cost but recites them in paragraph after paragraph of monotonous regularity.

There are no references given although the material has been selected from many sources and undoubtedly represents intensive bibliographic research. The author's connection with the American Iron and Steel Institute would indicate that he had spared no pains in collecting his material. Certainly a selected bibliography would greatly enhance the technical value of the book.

The scope of the book makes it unsuitable as a text as it indeed is not intended to be. As a popular story it would have been better had it been expanded to at least twice its present length. Nevertheless it contains much important information and should prove a valuable reference book to all those who are actively or casually interested in the iron and steel industry.—*James O. Lord, Associate Professor of Metallurgy, Ohio State University.*

Steel in Action, by Charles M. Parker, American Iron and Steel Institute. The Jaques Cattell Press, 1943. Lancaster, Pennsylvania. 221 pages. Price $2.50.

Frontiers of Cytochemistry

Frontiers of Cytochemistry is based on a symposium which was organized in honor of Dr. R. R. Bensley for his notable achievements in the field of histochemistry. This special symposium presented at the University of Chicago on November 13, 1942, was limited to the theme of the physical and chemical organization of the cytoplasm, the principal subject of the investigations of Dr. Bensley and his students for the past decade.

Most biologists will find this volume of especial value and interest for in this collection of papers is presented not only an historical account of the rapid progress made in recent years in this field of fundamental knowledge but the lines along which new discoveries may be expected in the future. Students of cellular biology who have been puzzled by the speed, orderliness and rhythmicity of cellular processes and the unique physical and chemical properties of the cytoplasm will find here significant information regarding structural, chemical and functional relationships.

Of particular interest to the morphologist is 1) the account of the isolation and chemical analysis of mitochondria, 2) the separation of the fibrous proteins ellipsin and plasmosin which are apparently responsible for the stability of cell structure and the sol-gel transformations in the cytoplasm respectively, 3) the discovery and separation of submicroscopic glycogen particulates and 4) the isolation and chemical analysis of the submicroscopic particulates of Claude. Doubtless the physiologist, pathologist, biochemist and physical chemist will find material of equal interest and profit.

Sixteen papers are listed in the table of contents, the titles and authors of which are as follows:

Foreword	Norman L. Hoerr
In Appreciation of Professor R. R. Bensley	E. V. Cowdry
The Chemical Structure of Cytoplasm as Investigated in Professor Bensley's Laboratory during the Past Ten Years	Arnold Lazarow
Some Considerations on the Application of Biological Oxidation-Reduction Reaction Systems to the Study of Cellular Respiration	E. S. Guzman Barron
Ultracentrifugal Studies on Cytoplasmic Components and Inclusions	H. W. Beams
Electrolytic Solutions Compatible with the Maintenance of Protoplasmic Structures,	Robert Chambers
Distribution of Nucleic Acids in the Cell and the Morphological Constitution of Cytoplasm,	Albert Claude
Experimental Epidermal Methylcholanthrene Carcinogenesis in Mice	E. V. Cowdry
Histochemical Analysis of Changes in Rhesus Motorneurons after Root Section,	Isidore Gersh and David Bodian
Methods of Isolation of Morphological Constituents of the Liver Cell	Norman L. Hoerr
Electrolytes in the Cytoplasm	Oliver H. Lowry
Fibrous Nucleoproteins of Chromatin	A. E. Mirsky and A. W. Pollister
The Ultrastructure of Protoplasmic Fibrils,	Francis O. Schmitt, Cecil E. Hall, and Marie A. Jakus
Mineral Distribution in the Cytoplasm	Gordon H. Scott
Studies on Macromolecular Particles Endowed with Specific Biological Activity	Kurt G. Stern
The Chemistry of Cytoplasm. (Reprinted from Science, 96: 389)	R. R. Bensley

—*A. A. Knouff.*

Biological Symposia, Vol. X. Frontiers in Cytochemistry. The Physical and Chemical Organization of the Cytoplasm. Edited by Norman L. Hoerr. vii+334 pages with illustrations and references. The Jacques Cattell Press, Lancaster, Pa. 1943. $3.50.

Medical Parasitology and Zoology

We have here a satisfactory textbook for students and, of most interest to me, an example of how an excellent medical school (Cornell University Medical College) has solved the problem of presenting a large and important subject to its students.

The newness of this subject to most American medical schools, and the presence of an already crowded curriculum, have frequently thwarted proper training in what is now considered an essential part of every physician's college experience. This book is especially recommended, therefore, to the attention of those educators who have this problem to solve.—*C. E. Venard.*

Medical Parasitology and Zoology, by Ralph Welty Nauss. 534 pp., illus., 1944. Price $6.00. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Bros., 49 East 33rd St., New York, N. Y.

Dynamical Analogies

This book, though only about a year in print, has been obtained by many engineers and physicists for personal libraries, and is becoming fairly well liked.

The book, in brief, takes the mathematics and relations that have been developed so highly for electrical circuits and applies them to mechanical (rectilineal and rotational) circuits and acoustical circuits for which the mathematics has not been developed as highly. The mechanical and acoustical circuits are transformed into corresponding electrical circuits for which the solutions are quite well known.

The material is written in a well-organized, simple style: the circuit elements and units are first well defined and then used in simple, and then in successively more complicated, combinations. The clarity and consistency of the diagrams used to illustrate these combinations is commendable.

After development of relations for various combinations of the elements, the author applies the material to corrective network, wave filters, and various electromechanical and acoustical driving and generating systems. These treatments are of great practical interest.

The transient relations that are used in corresponding analogies are obtained by operational calculus methods, and the mathematics is somewhat too abbreviated here. The addition of a general set of operational calculus formulas would be of real value. The Reciprocity, Thevenin's and Superposition Theorems are also applied to mechanical and acoustical systems.

There is, in addition to practical applications scattered throughout the chapters on driving and generating systems, a chapter on applications at end of book—but while the list of applications is inclusive enough, the treatments of the applications are too brief.

The book, though perhaps somewhat more abbreviated than necessary, is a very valuable and interesting one.—*Kenneth P. Yates.*

Dynamical Analogies, by H. F. Olson. 196 pp. D. Van Nostrand, 1943.

Heat and Thermodynamics

A new and considerably improved edition of Professor Zemansky's book dealing with thermodynamics for students preparing for career in physics or engineering. The second edition is nearly the same length as the earlier edition, but the contents have been rewritten in a great many places. New sections have been added and sections deleted. A considerable amount of illustrative material and graphs have been inserted at various points. The problem lists at the chapter-ends have been revised and improved. This second edition can be recommended for use with advanced undergraduates or beginning graduate students.—*Harold H. Nielsen.*

Heat and Thermodynamics, by Mark W. Zamansky, Ph.D. McGraw-Hill Book Company, New York. $4.00.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIV MAY, 1944 No. 3

THE FOREST RESOURCES OF AUGLAIZE COUNTY, OHIO[1]

LESLIE W. GYSEL,
The Ohio Agricultural Experiment Station,
Wooster, Ohio

This report is based on a county survey which was carried out according to the methods specified by the state-wide Ohio Forest Survey (1), a project designed to provide facts essential to public and semi-public agencies concerned with land-use planning for the improvement of the conditions of land tenure, for the integration of forestry and farm programs, and for the development of a rural works program. To obtain these facts, information has been collected concerning the quantity of timber, the location and size of all woodlands, the forest type and condition class of each, the economic aspects of the woodlands, and woodland management problems.

Briefly, the survey methods are as follows. Tracings are prepared from aerial photographs to show the location, shape, and area of all existing woodlands. A random sample of these woodlands is selected for cruising, the percentage selected varying in accordance with the total number of woodlands. From the total of 1,496 woodlands in Auglaize County, 504 were selected for cruising. The timber inventory is based on a tally of the species and diameter of each tree in a series of mechanically located fourth-acre plots established within the individual woodlands. Intensity of cruise of an individual woodland varies inversely with the acreage of the woodland. Of the 16,001 acres of woodland in Auglaize County, timber on 1,772 acres was tallied, affording a 11.1 per cent cruise. Forest cover type and condition class based on field inspection are determined for all woodlands, both cruised and uncruised. The distribution of reproduction by species and size class is recorded for hundredth-acre plots established in cruised woodlands.

GENERAL DESCRIPTION OF THE COUNTY

Physical Features:

Auglaize County is located in the west central part of Ohio, 19 miles from the Indiana border and 72 miles from the Michigan border. The total area is 397 square miles or 254,080 acres which is divided into 14 townships, only six of which have 36 sections.

The terrain of a large part of the county is gently undulating. Some large areas, however, are nearly level and others hilly. The undulating land is, in general, ground moraine and the hill areas are recessional moraines, three of which occur in the county. The whole region is covered by the Lake Wisconsin Drift which overlies limestone bedrock, the Niagara Limestone in the southern part of the county and the Monroe Limestone in the northern part (5).

---

[1] Acknowledgments: This survey was conducted in 1940 through the cooperative efforts of a group of organizations, mainly: The Work Projects Administration, The Department of Forestry of the Ohio Agricultural Experiment Station, The Agricultural Conservation Association, The Central States Forest Experiment Station, The Ohio Forestry Association, The Izaak Walton League of America, and numerous wood-using industries throughout Ohio.

Of the soils which have developed from this glacial drift, the Miami silty clay loam is the most important in regard to area and is found mainly on undulating or rolling terrain with fair to good surface drainage. Bellefontaine silt loam occurs on the well-drained areas of the hills. Of the soils which occur on the level to slightly undulating terrain, the Crosby and Brookston silty clay loams are dominant. Two forest humus layer types are predominant in the woodlands of the county, the course mull which occurs mainly in the closed ungrazed forested areas, and the firm mull which occurs in the open grazed farm woods. The depth of these humus layers varies approximately from 2 inches to 12 inches, and is greatest in the poorly drained soils.

Cultural Features:

The most important factors affecting the original vegetation, other than the physical, are directly or indirectly due to the influence of man. Therefore, in order to explain the extent, condition, and type of farm woodlands in the county, the cultural features must be considered. An analysis of the economic data for Auglaize County indicated that farmwoods are a secondary source of income for the farms of the county because of the adaptability of the land for intensive agriculture, the relatively high land values, and the type of farming. In general, the combination of good soil and good agricultural methods has made the cultivation of crops and the raising of cattle, sheep, and hogs profitable. As a result of the high value of these products and of the land, the farmwoods have become a neglected asset.

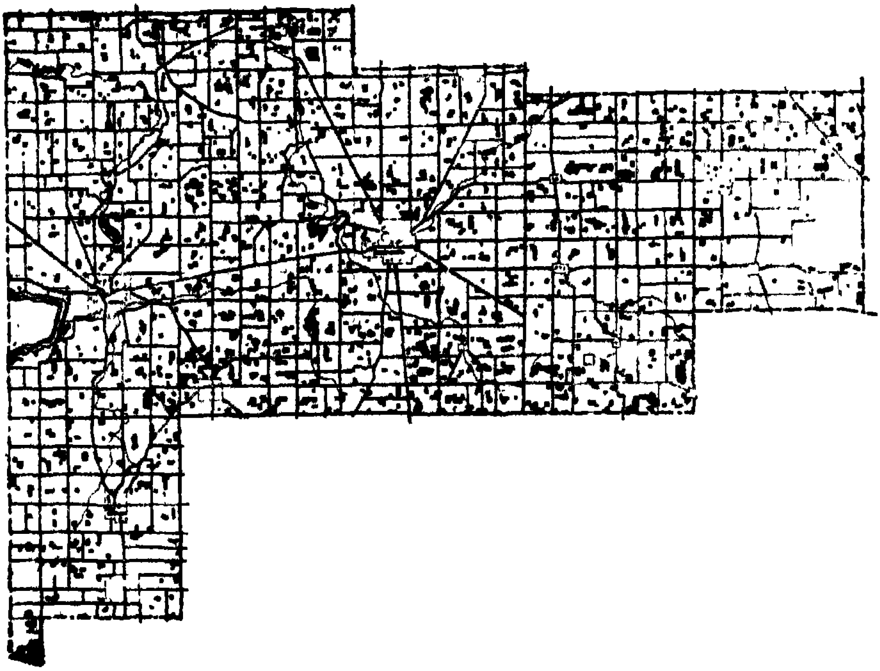


FIG. 1. Forest Cover of Auglaize County, 1940.

FOREST DESCRIPTION

The Original Forest Cover:

In order to fully understand the present forest conditions, it is necessary to have at least a general knowledge of the original vegetation. According to

Transeau and Sampson swamp forests covered most of the county with beech and sugar maple as the dominant species on the well-drained sites. This large area of swamp forest consisted of a number of different phases which are designated by the following types: Willow-Cottonwood-Sycamore, Elm-Ash-Maple, Bur Oak-Swamp White Oak-Hickory, and Red Oak-Basswood. Gordon (2) states that associated with the beech and sugar maple on the better drained sites were Northern red oak, white ash, yellow poplar, white oak, red maple, bitternut hickory, shagbark hickory, buckeye, basswood, blue beech, and hop hornbeam. According to the field notes of the original land survey, beech was apparently a much more important dominant than is indicated by present conditions (Figs. 3 and 4).

Williamson (4) states that "up to 1845 Auglaize County was unsurpassed for its stately trees of many valuable varieties. The splendor of its flora was displayed in its oaks, black walnut, butternut, poplar, hickory, ash, wild cherry, linden, tulip tree, with almost endless varieties of trees of minor value." After 1832 a part of this forest was cleared for agricultural purposes, especially during the period from 1845 to 1856.

The Woodlands of the Present Day:

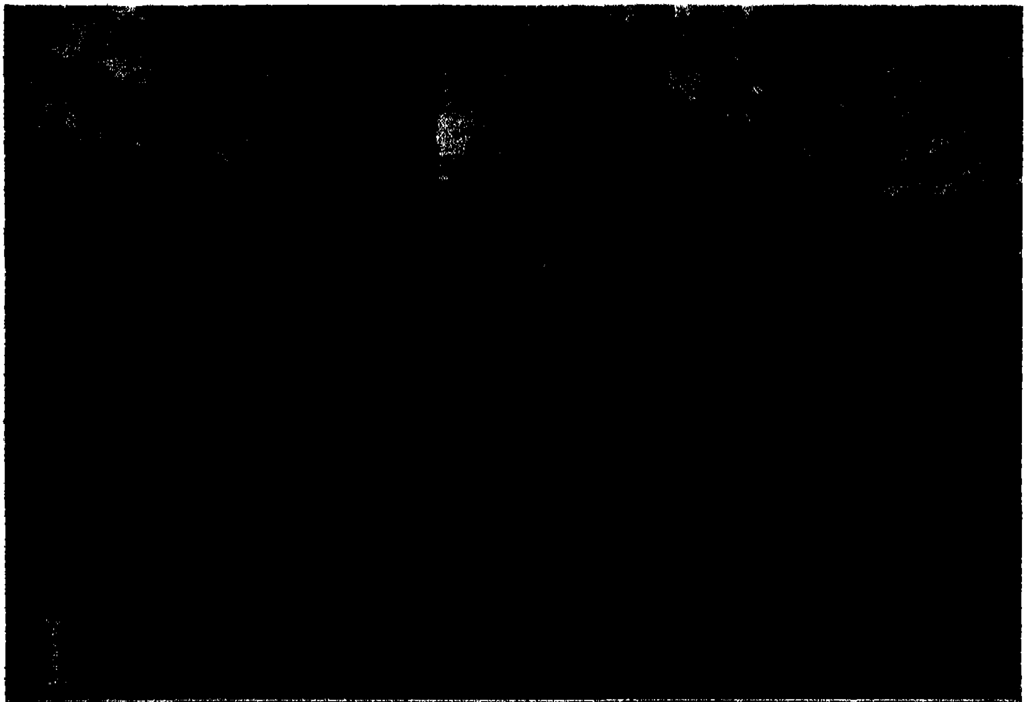
The forest lands of the county are now, with few exceptions, small farm woodlands. There are 1,496 of these woodlands which make up a total area of 16,001 acres, or 6.3 per cent of the total area of the county. The individual woodlands vary considerably in size; the smallest considered in the survey was 3 acres and the largest was 122 acres. There are very few large woods, however, the average woodland for the county being only 10.9 acres in area. In general the woodlands are quite evenly distributed throughout the county except in the flat prairie land where there is a relatively small number per unit area.

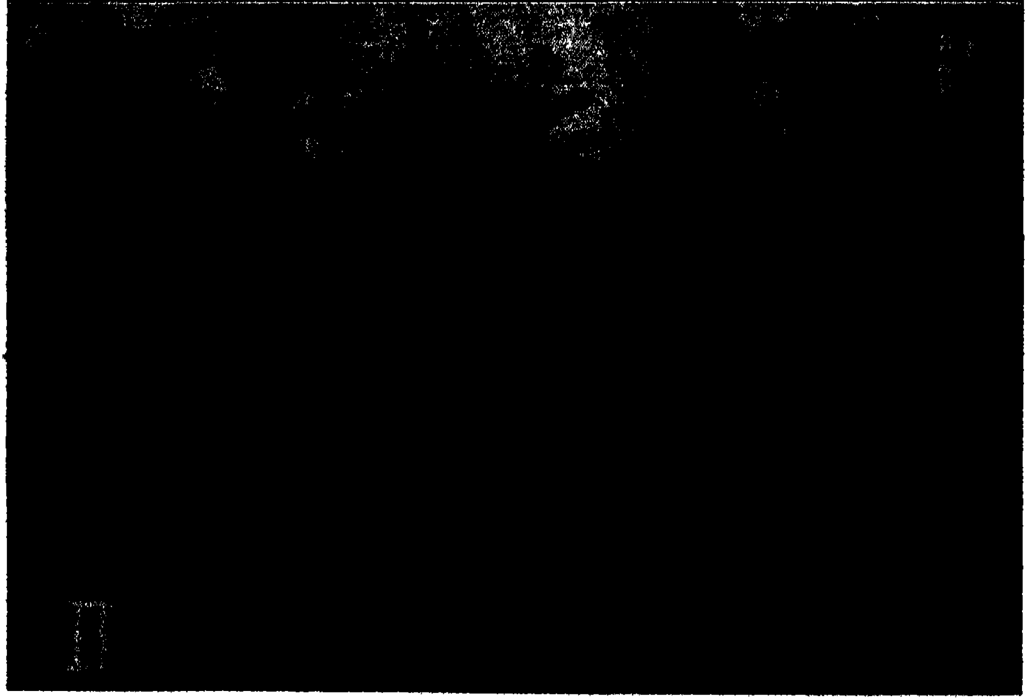
Condition Classes: Each of the farm woodlands in the county has been classified according to the character of its stocking. The unit of this classification is the condition class which is important because a knowledge of woodland structure is essential for a complete understanding of the management problems, the economic values, and the ecological aspects of the forest types. The eight condition classes are illustrated pictorially and the descriptive characteristics of each as designated in the survey are given:

Class I—All-aged Stand (Plate I).
- (a) The trees are well distributed from the reproduction to the medium or large timber size classes.
- (b) The crown canopy is closed or nearly so.
- (c) The deposit of leaf litter is good to excellent.
- (d) There is little or no evidence of grazing.

Class II—Transition Stand (Plate I).
- (a) Trees in the reproduction class are sparse or lacking.
- (b) The crown canopy is 75 per cent or less.
- (c) The woodland is, or until very recently has been, grazed.
- (d) Grass and weeds are becoming established in the openings.
- (e) The deposit of leaf litter is poor.

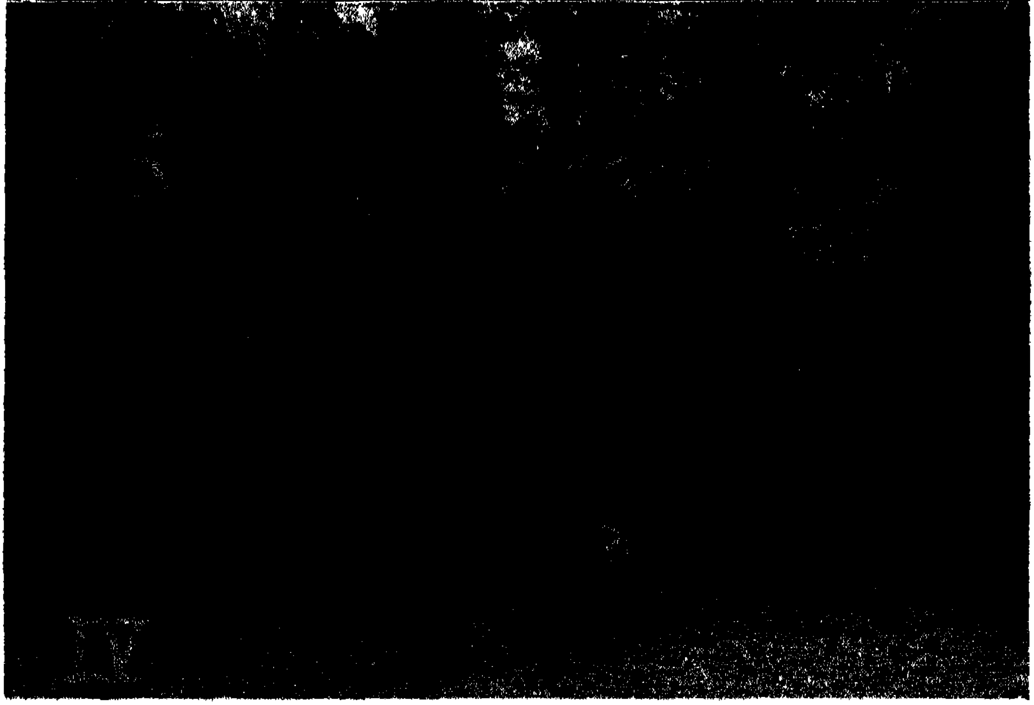
Class III—Open-park Stand (Plate II).
- (a) Trees in the reproduction class are sparse to lacking, and there are few trees in the pole size class; trees in the small timber class and above are normally distributed, or approximately so.
- (b) The crown canopy is less than 75 per cent.
- (c) There are at least 25 trees per acre.
- (d) The stand has been intensively grazed over a long period of years.
- (e) There is sod present.





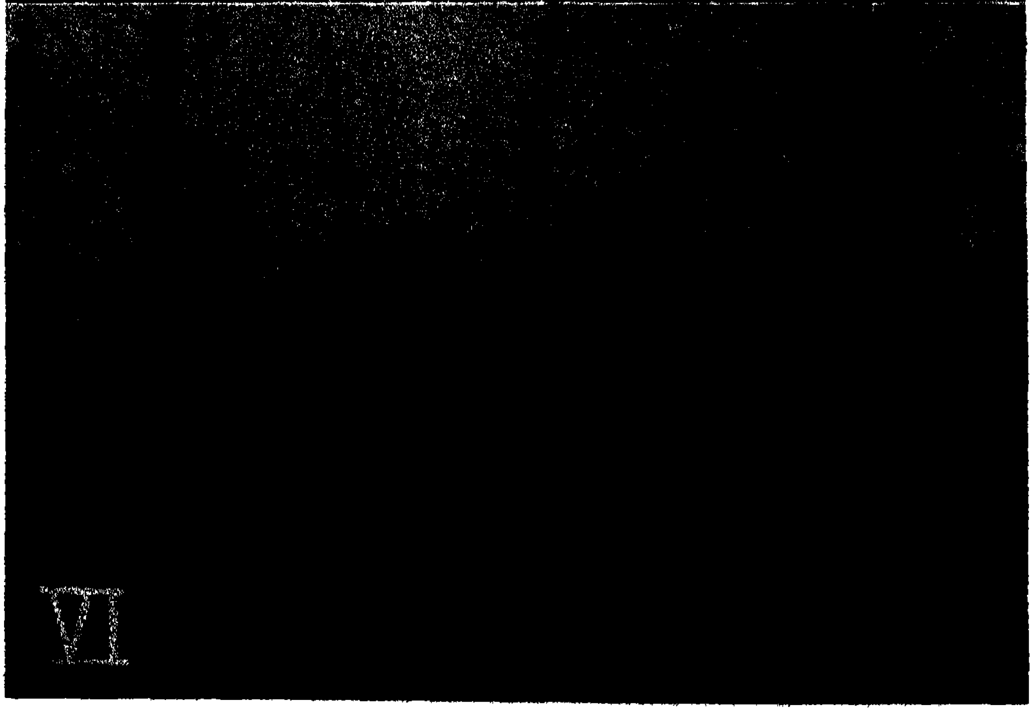
I. The presence of all diameter classes from reproduction upward is the outstanding characteristic of Class I woodlands.

II. The almost total absence of trees of reproduction size, but an otherwise good distribution of size classes, characterizes Class II stands.



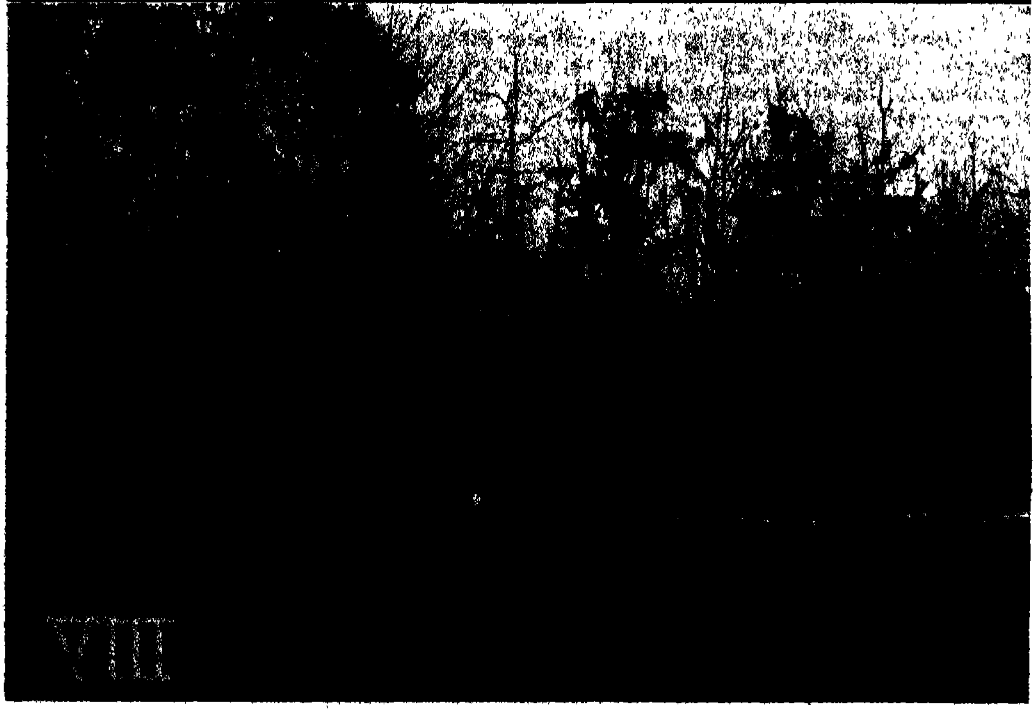
III. Features which distinguish Class III woodlands are: the open condition of the stands, the presence of sod on the forest floor, and the preponderance of trees in the larger diameter classes.

IV. Well-stocked stands made up almost exclusively of pole-size trees are called Class IV.



V. Poorly stocked pole stands are called Class V. Grass sod is usually present in the openings.

VI. Pole stands with from 6 to 18 larger trees per acre in the overstory are characteristic Class VI woodlands.



VII. Definite two-storied forests caused by the absence of one or more diameter classes of pole size are called Class VII.

VIII. Trees of reproduction size, originating either from clear-cut stands or volunteer growth on abandoned fields, are mapped as Class VIII.

Class IV—Well-stocked Pole Stand (Plate II).
- (a) The trees are mainly in the size classes below the small timber class, i.e., less than 13.0 inches d.b.h. The number of trees in the small timber class and over does not exceed 6 stems per acre.
- (b) The crown canopy covers 60 per cent or more of the area.

Class V—Scattered Pole Stand (Plate III).
- (a) Resembles Class IV, but is not as heavily stocked.
- (b) The crown canopy is less than 60 per cent.
- (c) Patches of sod are usually present.

Class VI—Pole Stand with Scattered Large Trees (Plate III).
- (a) The trees in the pole and reproduction classes approximate the number of those found in Class I stands.
- (b) The number of trees in the small timber class and over is between 6 and 18 per acre.

Class VII—Two-storied Stand (Plate IV).
- (a) A stand in which the trees are well-distributed throughout the size classes with the exception of the pole size class which is scarce or lacking.
- (b) The over-story has at least 20 trees per acre, and there is a total of at least 25 trees per acre 3.0 inches d.b.h. and over.

Class VIII—Reproduction Stand (Plate IV).
- (a) The ground area is at least 25 per cent covered by well-distributed tree reproduction which is 3 feet or more in height.

The Class I woodlands are of special interest because they are the only remaining stands which are stocked and have a composition similar to the original forests. However, this class covers only 867 acres, or 5.4 per cent of the total woodland acreage (Plate I) and therefore cannot be considered of major economic importance. Nevertheless a knowledge of the make-up of these stands is valuable for formulating management plans. The data presented in the stand and stock table (Table I) show very clearly the balanced character of the stand. The total basal area for the average acre is 79.4 square feet for this class. Basal area is the term used to designate the area in square feet of the cross section of a tree 4½ feet above the ground. It may be applied to a single tree or it may be the combined area of the trees on some given area, usually one acre. In this discussion it is on a per acre basis. In comparison with the other classes, this figure is somewhat greater, but due to the fact that in many cases the largest trees have been removed by selective cuttings from Class I stands, it is lower than that which would have been characteristic of virgin stands. In areas in which many of the large trees have been preserved, the total basal area averages slightly more than 100 square feet per acre, the largest recorded being 118.8 square feet. The reproduction is generally abundant and of good quality; the number of stems, which averages 934 per acre, is considerably greater than for any of the other classes.

Condition Class II is much more important in the county than Class I because the woodlands in this classification make up approximately 25 per cent of the total woodland acreage of the county. In form, as shown by the number of stems and basal area of the typical acre (Table I), the stands are not greatly different than those in the Class I condition; however, the average number of stems in the reproduction size class is about two-thirds less.

The Class III woodlands represent advanced stages of forest stand decadence. The data for the average acre of the class indicate the lack of trees below 13 inches in diameter. However, the distribution in the larger size groups is very similar to that of the first two condition classes. There is only a small amount of reproduction in these woodlands which in many cases consists entirely of inferior species; the average of 300 stems per acre of which a large percentage are small seedlings is the lowest number for all of the condition classes. Approximately 17 per cent of the total woodland acreage is in this class, and therefore it is an important part of the forest area.

Class IV and V woodlands generally result from the growth of sprouts and advance reproduction after the clear-cutting of a stand, or from the natural regeneration on abandoned farmland. In regard to the number of trees per acre, these stands are almost as dense as those in the Class I condition, but the basal area is less than half. Both of these classes together comprise only 11 per cent of the total forest acreage, and generally the stands are small in size.

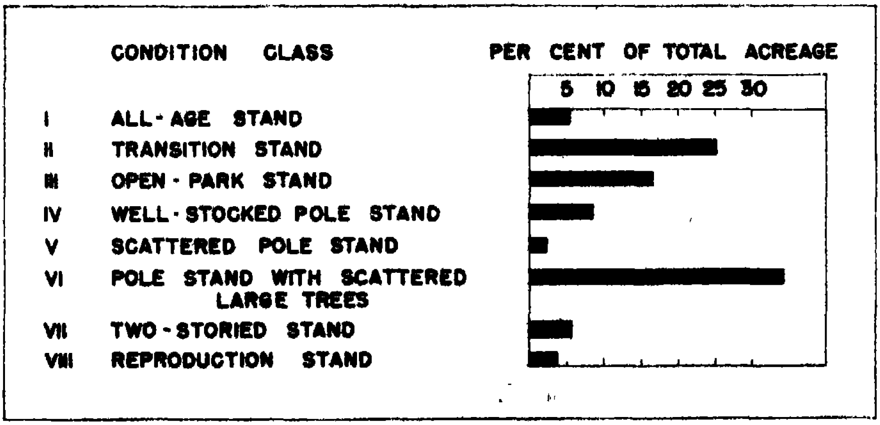


FIG. 2. Distribution of woodland acreage by condition class.

Class VI woodlands are the most typical of the county. The largest number of stands and also the greatest acreage are in this class. Woodlands in this condition occupy 34.1 per cent of the total woodland area, or 5,449 acres. This form of stand generally results from severe cuttings in which all but a few of the larger cull trees are removed. Due to the small number of trees above the pole size, the basal area is relatively low, although the total number of stems in this class approximates the number of those found in Class I stands. Although approximately 75 per cent of the stands are grazed, it is generally light so that reproduction is quite abundant; the typical acre of a Class VI woodland has an average of 751 stems in the reproduction size class.

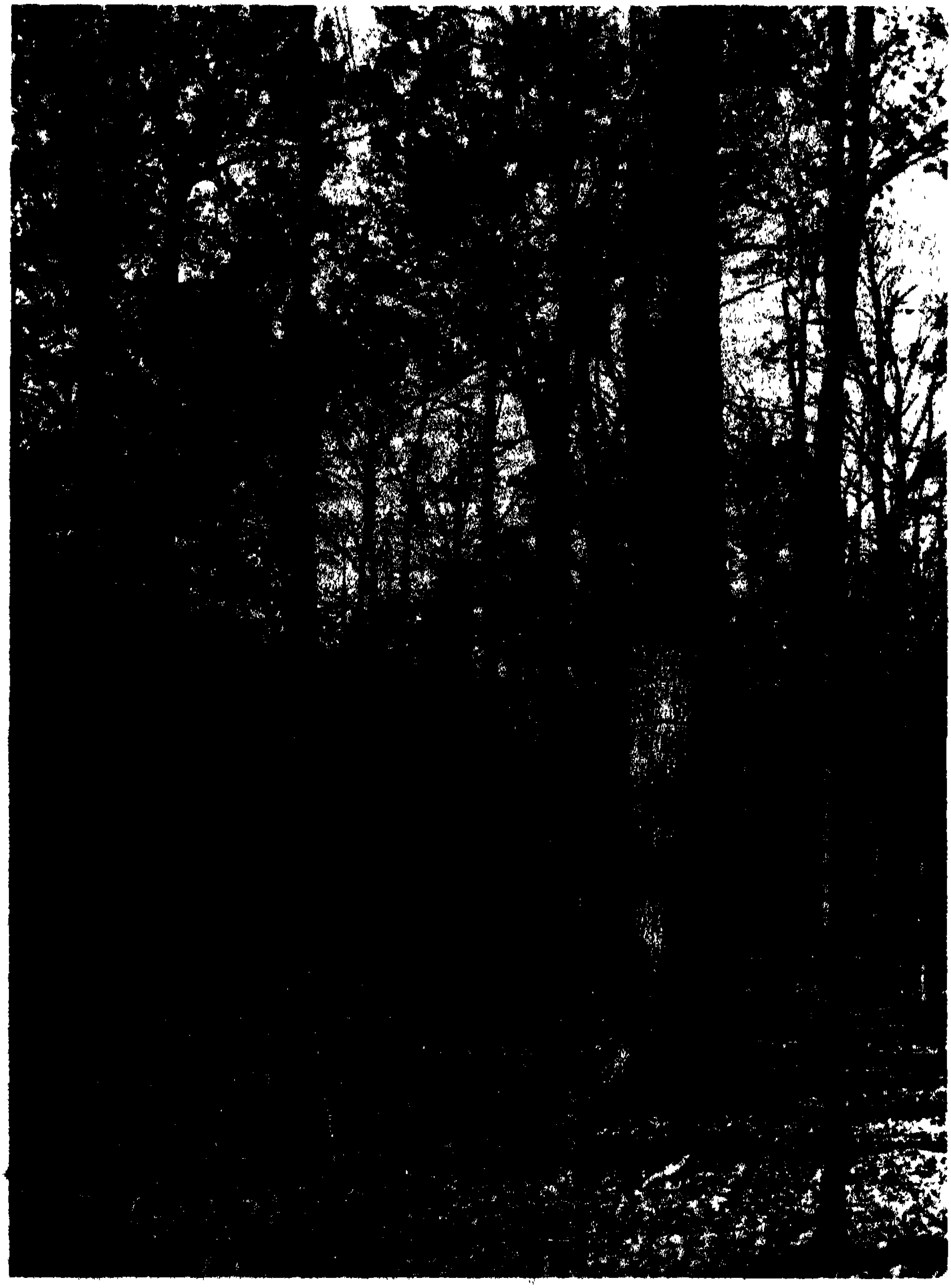
Class VII is relatively unimportant in regard to area covered since it comprises only 5.1 per cent of the total woodland acreage. The elimination of grazing from old Class II or III stands and subsequent establishment of reproduction may result in a two-storied woodland.

Class VIII woodlands are found on clear-cut forest land or on abandoned farmland. Since most of the cleared land is readily adaptable and valuable for farming, only 3.4 per cent of the total woodland acreage has reverted to this condition.

TABLE I

STAND AND STOCK TABLE BY CONDITION CLASS—TYPICAL ACRE

D B H	CLASS I		CLASS II		CLASS III		CLASS IV		CLASS V		CLASS VI		CLASS VII		D B H
	No. Stems	B.A. Sq. Ft.	No. Stems	B.A. Sq. Ft.	No. Stems	B.A. Sq. Ft.	No. Stems	B.A. Sq. Ft.	No. Stems	B.A. Sq. Ft.	No. Stems	B.A. Sq. Ft.	No. Stems	B.A. Sq. Ft.	
4	47.4	4.7	35.4	3.5	7.1	.7	71.6	7.2	39.8	4.0	51.1	5.1	25.9	2.6	4
6	26.9	5.4	21.2	4.2	6.9	1.4	32.6	6.5	22.2	4.4	28.1	5.6	12.5	2.5	6
8	17.0	5.1	14.1	4.2	7.6	2.3	15.1	4.5	14.2	4.3	17.4	5.2	9.6	2.9	8
10	12.3	6.1	10.6	5.3	8.2	4.1	8.4	4.2	10.0	5.0	11.9	5.9	7.5	3.7	10
12	10.7	8.6	9.3	7.4	8.2	6.6	5.2	4.2	7.3	5.8	8.5	6.8	6.9	5.5	12
14	7.5	8.2	7.4	8.1	7.1	7.8	2.7	3.0	4.1	4.5	5.9	6.5	5.5	6.0	14
16	6.3	8.8	5.6	7.8	6.1	8.5	1.2	1.7	2.1	2.9	4.3	6.0	4.4	6.2	16
18	4.8	8.6	4.2	7.6	4.2	7.6	.9	1.6	1.0	1.8	2.9	5.2	3.3	5.9	18
20	3.4	7.5	2.7	5.9	3.0	6.6	.7	1.5	.4	.9	2.1	4.6	2.1	4.6	20
22	2.3	6.0	2.0	5.2	1.8	4.7	.1	.3	.1	.3	1.3	3.4	1.3	3.4	22
24	1.0	3.1	1.0	3.1	1.3	4.0	.1	.3	.1	.3	.7	2.2	.8	2.5	24
26	.8	3.0	.8	3.0	.8	3.0	.1	.4	.1	.4	.4	1.5	.6	2.2	26
28	.5	1.0	.4	1.7	.4	1.7	.1	.4	.1	.4	.2	.8	.2	.8	28
30	.3	1.5	.2	1.0	.2	1.0	.1	.5	....	....	.2	1.0	.2	1.0	30
32	.2	1.1	.1	.6	.2	1.1	....	....	....	....	.1	.6	.2	1.1	32
34	.1	.7	.2	1.5	.2	1.5	....	....	....	....	.1	.7	.2	1.6	34
Total	141.5	79.4	115.2	70.1	63.3	62.6	138.9	36.3	101.5	35.0	135.2	61.1	81.2	52.5	Total



A Class I white oak-sugar maple woodland in Pusheta Township.

Forest Types: Nine forest types were selected for the purpose of classifying the woodlands as to species composition. A cover type in this survey is defined and named by the dominants which comprise 50 per cent or more of the crown cover, or, if there are no dominant species, by the general composition of the stand. Each woodland is designated by one cover type.

The Mixed Hardwood Type: This type is the most extensive in the county, although only slightly more so than the Oak-Hickory type. It occupies 21.4 per cent of the total woodland area, or 3,432 acres (Fig. 3), and is therefore of considerable importance. Many of the better woodlands of the county are of this type, since 37 per cent of the total acreage of the type is in Classes I and II. However, there is also approximately an equal acreage in Class VI.

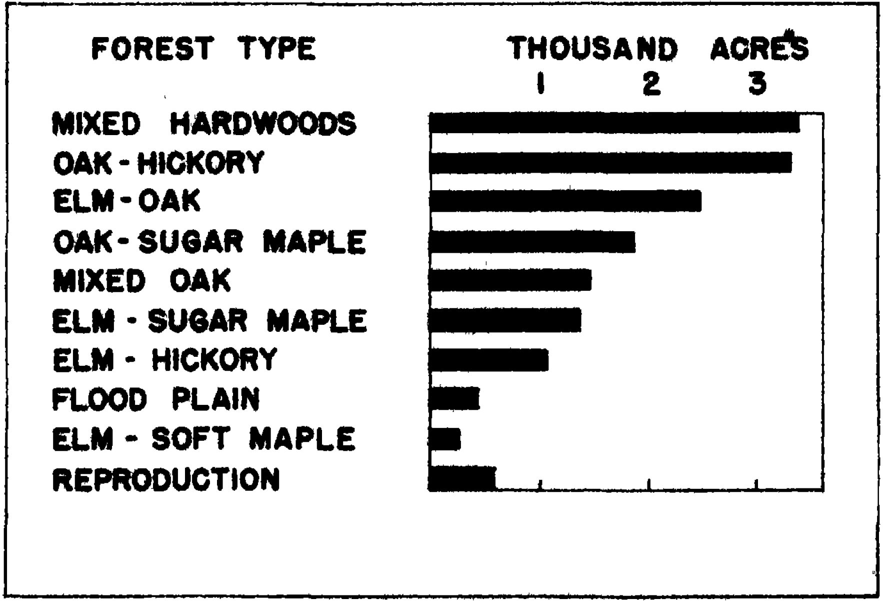


FIG. 3. Distribution of woods acreage by forest type.

As the type name indicates, it is composed of a mixture of hardwoods in which there is no one or small group of species which dominate the stand. The American elm is the most important tree in regard to total basal area and number of stems. It is generally a scattered component and is distributed throughout the various size classes. Of the remaining species which make up the type, hickory, white ash, sugar maple, basswood, beech, and red oak are the most prevalent. In individual woodlands, however, various other species of the total of 48 which were reported for the type may also be important.

Most of the major type species are well represented in the reproduction. American elm is again the most important species with ash and hickory of secondary importance; white and red oak are very sparse. Less desirable small tree species such as *Crataegus*, blue beech, and hop hornbeam, are quite abundant.

Approximately one-half of the woodlands of this type are well-drained and the remaining half partially or poorly drained. The individual woodlands generally occur on undulating or slightly rolling topography and may therefore be composed of a number of type phases. Various phases of the swamp forest such as elm-ash-maple, bur oak-swamp white oak-hickory, and red oak-basswood probably covered most of these sites originally. Beech, no doubt, was also an important component as shown by the original land survey data (Fig. 4).

Oak-Hickory Type: Second in importance from the standpoint of acreage covered is the Oak-Hickory type, which has a general distribution throughout the county. The economic value, however, is relatively small because of the large proportion of pole size elm and hickory and the poor form of the larger trees Most of the stands have been quite heavily cut and grazed. Approximately 46 per cent of the total acreage of the type is about equally divided between Classes II and III, and 35 per cent is in Class VI.

There are two sub-types of the Oak-Hickory type One occurs on well- or moderately well-drained sites and the other on poorly drained habitats. The former is the most important since only about one-seventh of the woodlands of this type are poorly drained. Hickory, white oak, American elm, red oak, miscellaneous hickory,[2] and white ash are the important components on the well-drained lands. On the poorly drained sites, hickory, American elm, swamp white oak, chinquapin oak, pin oak, bur oak, soft maple, and black ash are the dominant constituents. Hickory and American elm are the most important species in the reproduction in both drainage conditions; the oaks are very sparse.

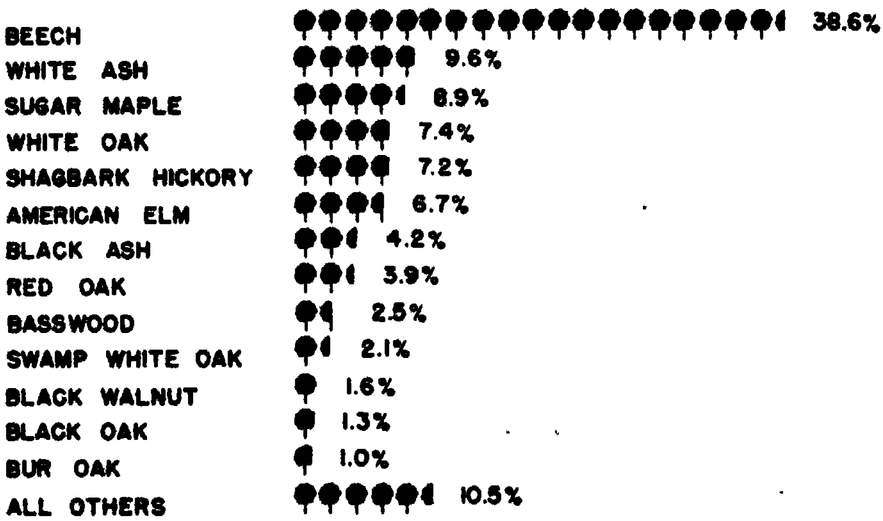


FIG. 4. Percentage composition of the number of stems in the samples of the original vegetation. From notes on the Original County Land Survey.

The Oak-Hickory type on the well-drained sites appears to be primarily the result of biotic factors such as cutting, grazing, and drainage in original stands of oak and sugar maple. The poorly drained Oak-Hickory sub-type was probably a transition phase of the original swamp forest.

Elm-Oak Type: The Elm-Oak type is quite similar to the Oak-Hickory type in regard to the percentage distribution of the woodlands in the condition classes. Various species of oaks, American elm, and hickory are the chief dominants.

---

[2] In this report miscellaneous hickories refer to those other than shagbark and shellbark hickory.

This type, since it includes 15.6 per cent of the total woodland acreage, is a significant part of the forest cover.

The Elm-Oak type occurs more frequently on the poorly drained sites than does the Oak-Hickory type. American elm, red oak, white ash, bur oak, swamp white oak, and hickory are the important components of the average stand. White oak and sugar maple are prominent associate species on the well-drained sites. In the reproduction, American elm, white ash, and hickory are abundant in all condition classes, whereas the lack of oak is very marked.

The Elm-Oak type probably became more important after the cutting and grazing of some of the phases of the original swamp forest. Evidences of such a change occur in Class VI stands in which many of the old cull trees are poorly shaped swamp oaks and the young growth is composed of elm, hickory, and white ash.

Oak-Sugar Maple Type: This type occurs most extensively on the well-drained sites and is found mainly in the central part of the county. Sugar maple, red oak, and white oak are the characteristic dominant species. Of the associate species, American elm, shagbark hickory, white ash, and basswood are the most important. Many of the stands are in excellent condition and are the most valuable woodlands in the county. As in other oak types, however, the oak reproduction is very sparse; American elm, sugar maple, and white ash are the most abundant in this size class.

The Oak-Sugar Maple type was probably a part of the original vegetation. Its former importance is not known, but the range of occurrence may have increased after settlement because of the improved drainage conditions in the swamp forest areas.

Mixed Oak Type: The Mixed Oak woodlands also occur on well-drained sites throughout the county. The type can be further subdivided into two sub-types, one which is limited to the best drained sites and the other to the moderately well-drained habitats. White and sometimes black oak are dominant on the former areas whereas red, bur, swamp white, pin and chinquapin oak are the most abundant on the latter. There are 27 other tree species listed for the type, most of which, however, are of minor importance. The principal associate species are American elm, shagbark hickory, basswood, sugar maple, beech, and white ash. From an economic point of view, this type is particularly important because of the high percentage of valuable species.

The early settlers probably found stands of mixed oak when they first arrived in the county. The original composition has, no doubt, changed since the time of settlement and is still changing as indicated by the small percentage of oak in the pole size class and the lack of this species in the reproduction. American elm, white ash, and hickory are the dominants of the reproduction size class.

Elm-Sugar Maple Type: Three species, sugar maple, American elm, and slippery elm make up approximately 50 per cent of the basal area and the number of stems of the type. These species are also the most abundant in the reproduction. However, from the present indications in the field, it seems possible that many of the stands were originally Beech-Sugar Maple. The severe cutting prevalent in this type may account for the dominance of American elm and slippery elm.

The center of distribution of the Elm-Sugar Maple type within the county is in the recessional moraine area which is generally hilly and well-drained. It is in this area that nearly all of the county's maple syrup is produced.

Elm-Hickory Type: The Elm-Hickory type has developed largely as a result of biotic factors. Of the total acreage, 69 per cent, or 728 acres, is included in Classes IV, V, and VI. No stands of the Elm-Hickory type were found in the Class I condition. Of the total number of stems in the type, 92.2 per cent are in the pole size class. Approximately 50 per cent of this class is divided equally between hickory and American elm; therefore the economic value of this type is low. Fortunately it covers only 6.6 per cent of the total woodland acreage.

The Elm-Hickory type occurs generally on moderately well-drained sites on which some phases of the swamp forest or the sugar maple types originally existed. After severe cutting in forest stands and on abandoned fields, the lack of oak reproduction and the abundance of elm and hickory reproduction favored the development of the present type of stand.

Flood Plain Type: The characteristic forest vegetation of the flood plain occurs mainly on the alluvial soils of the first bottoms of the Auglaize and St. Marys rivers. This vegetation is influenced by the high water table and, therefore, the type is considered as a phase of the swamp forest. Of the total woodland acreage, 2.1 per cent, or 343 acres, was classified as the Flood Plain type.

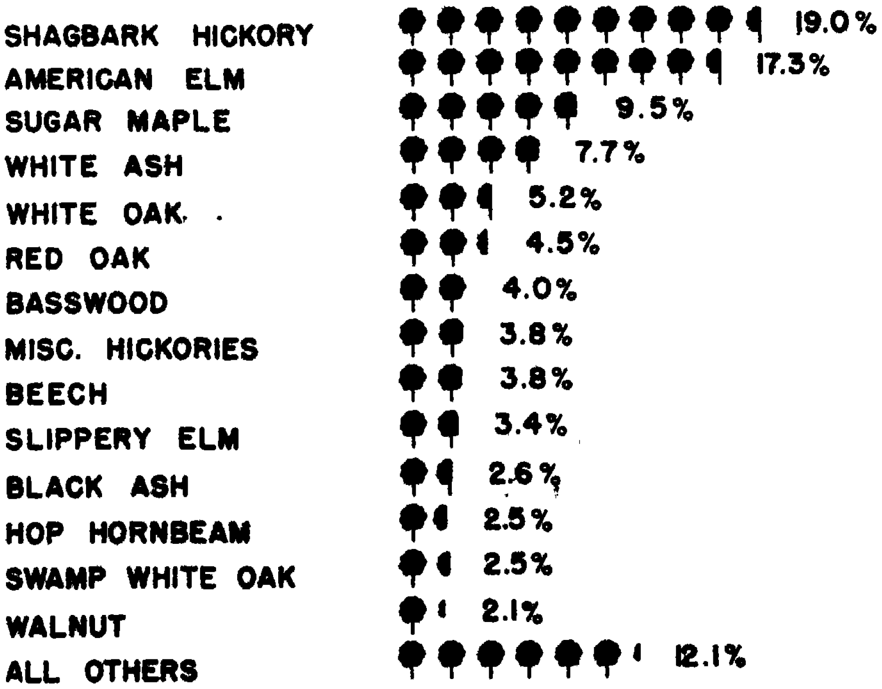


FIG. 5. Percentage composition of the number of stems in the farm woodlands, all types (from survey data).

The fact that 41.5 per cent of the acreage of the type is in Classes I and II indicates that severe cutting has been less extensive than in any of the other types. Part of the reason for this is the small number of valuable species. American elm is dominant with one-fourth of the total basal area. Other species which make up the mixed stand are: cottonwood, swamp white oak, sycamore, hackberry, honey locust, white ash, willow, and box elder.

There are other phases of the swamp forest on many areas bordering Lake St. Marys which might be considered as variations on the Flood Plain type. Where the water is quite deep throughout the year, cattails are the main vegetation, but towards the edges of the swamps in areas which have only an inch or two of standing water in the summer, willow is a scattered species. Further back on the better drained areas, cottonwood, American elm, and white ash are the dominants. On those sites which are only periodically flooded, swamp white oak and American elm are the main species which are associated with sycamore, cottonwood, pin oak, and white ash.

Elm-Soft Maple Type: This type covers only 191 acres, or 1.1 per cent of the total woodland area, and includes only a few valuable species. The economic value is therefore small. It is of ecological interest, however, since it occurs mainly on the poorly drained sites and was probably a phase in the original swamp forest. White ash is an important component of the type from the standpoint of the number of stems, but the basal area is relatively small because a large percentage of the trees are in the pole size class. Sycamore, black ash, pin oak, beech, basswood, cottonwood, hickory, and swamp white oak are the most prevalent associate species.

A Summary of the Species Composition of All Types: The species of the oak genus which occur in the county are collectively the most important vegetation of the woodlands from the standpoint of value, volume and percentage of cover. Four of the oaks—red, white, bur, and swamp white—comprise 28.3 per cent of the total basal area of all the types; chinquapin, pin, black, and shingle oak make up a small additional percentage. However, all of the oaks make up only approximately 12 per cent of the total number of stems of all types (Fig. 5) which indicates that there is a relatively high proportion of the trees in the large size classes. The small amount of oak in the reproduction and pole size classes has been noted in all types.

It has been quite apparent from the previous discussion of the types that two of the most important tree species in regard to the total number of stems and basal area are the American elm and shagbark hickory. The sum of their basal areas accounts for 27.7 per cent of the total for all types and is just slightly less than that of the oaks, but in this case the percentage of the number of stems is about three times that of the oaks, or 36.3 per cent of the total number of stems of the county. The number of trees in the small size classes is, therefore, relatively large.

The other species which merit special mention are sugar maple and white ash. Both occur predominately in the pole size class although not to such a marked extent as hickory and elm. Other species which occur extensively throughout the county are basswood, miscellaneous hickory, beech, slippery elm, black ash and walnut.

ECONOMIC ASPECTS OF THE WOODLANDS

Home Consumption of Forest Products:

Accurate data pertaining to the uses and values of the various woodland products are very hard to obtain because the majority of the woodland owners had no written records and were only able to make rough estimates. However, it is possible to designate general trends from the data obtained. The wood products which are used directly on the farm make up the most important part of the income from the farmwoods. Fuelwood is by far the most important product and was noted for almost every woodland for which the information was available. Only a small number of woodland owners in seven townships reported regularly yearly sales of wood or wood products. Many, however, reported occasional sales of saw timber, fuelwood, and posts.

Returns from Woodlands:

In order to improve the neglected farm forestry conditions in the county, considerably more interest in this field must be created. Probably the only way to create this interest in the majority of cases is to show resulting profits. A good example of a profitable 53-acre woodland, an ungrazed all-aged stand of the Elm-Oak type, was found in Salem Township. A record of the returns is shown in Table II. Under a continuous yield plan of management, the owner has received $175.43 yearly or $3.31 per acre since 1904. Another farmer reported a return of $8.97 per acre over the same period.

TABLE II

RETURNS FROM 53-ACRE WOODLAND

YEAR	ITEM, QUANTITY, AND UNIT VALUE	VALUE RECEIVED (Dollars)
1904	Maple syrup, 10 gal. @ $1.00 per gal	$ 10.00
1905	White oak, 400 trees @ $10 per tree	4,000.00
	Fuelwood sold, 200 cd. @ $1.00 per cd.	200 00
1906	Fuelwood sold, 200 cd. @ $1.00 per cd	200 00
1916	White ash	700 00
1918	Fuelwood sold, 40 cd. @ $2.00 per cd.	80.00
1920	Ironwood for rollers	5 00
	Oak, 2,500 bd. ft. @ $20 per M bd. ft.	50 00
	Fuelwood sold, 50 cd. @ $1.00 per cd.	50.00
1923	Oak, 2500 bd. ft. @ $20 per M bd. ft	50.00
1925	Elm and Hickory, 3750 bd. ft. @ $20 per M bd. ft	75 00
1929	Pin Oak, 65 trees @ $2.00 per tree.	130 00
1930	Oak and Elm for farm use, 2,000 bd. ft. @ $20 per M bd. ft.	40 00
1935	Elm and Red Oak, 1,500 bd. ft. @ $16.50 per M bd. ft.	25 00
1939	Ironwood for rollers	6 00
1905 to 1940	Fuelwood for farm, 20 cd. per year @ $1.00 per cd.	700 00
	Total income received	$6,321 00

The thirteen woodland owners who reported a yearly production of maple syrup produce 1,067 gallons for an annual return of $1,803. The largest single producer maintains a 50-acre woodland for this purpose only on which 600 trees are tapped each year. The average production is 300 gallons per year, which at $1.50 per gallon yields $450 per year or on a per acre basis $9.00.

Markets and Utilization:

An investigation of the wood-using industries shows that there are markets within the county for all of the more important tree species. In addition it was found that two of the industries are importing high-quality hardwoods from other states or from distant markets in Ohio, namely, white ash, hickory, and sugar maple, which could be grown in properly managed farmwoods within the county.

The wood-using industries are an important part of the economic assets of the county. There are a total of 24, of which 17 are sawmills. The latter cut an average of 2,400 M bd. ft. per year, most of which is local timber. The other industries which include manufacturers of spokes and wheels, furniture, white ash handles, and wood products for constructional purposes utilize 4,230 M bd. ft., a part of which is imported into the county. For the operation of these industries, 330 persons are employed permanently and 34 part time.

WOODLAND MANAGEMENT

Methods of Cutting:

In the few stands in the county which are somewhat similar to the virgin forests, a selective type of cutting should be made in which only the mature trees are removed. This basic type of cutting should, in practice, be limited by the amount of annual growth so that a sustained yield results. The largest amount of cutting in the near future, however, will necessarily be in the poorer stands. In these cases the object should be to re-establish a well-stocked all-aged stand of valuable trees so that in the future a sustained yield plan may be carried out. The poorly shaped or decayed trees, whether they are mature or immature, should be removed as quickly as they can be utilized for fuelwood or posts to make room for the more valuable species, especially in dense stands. In more open stands, however, care must be taken to maintain a suitable crown cover for the purpose of creating a favorable environment for desirable reproduction.

Grazing:

One of the most important factors which will help to create more productive stands of timber in the county is the elimination of grazing from the farmwoods. It was found that 1,122 woodlands, 75 per cent of the total number, are grazed by cattle, sheep, or hogs. As a result, deterioration of these woodlands is gradually taking place by the elimination of tree reproduction as well as the herbaceous and shrubby layers, the increase of grass sod, the loss of the litter layer, the compacting of the humus layer and the surface mineral soil (Plate VI), the exposure and injury of the roots of certain tree species, and in some instances the mechanical injury to tree trunks.

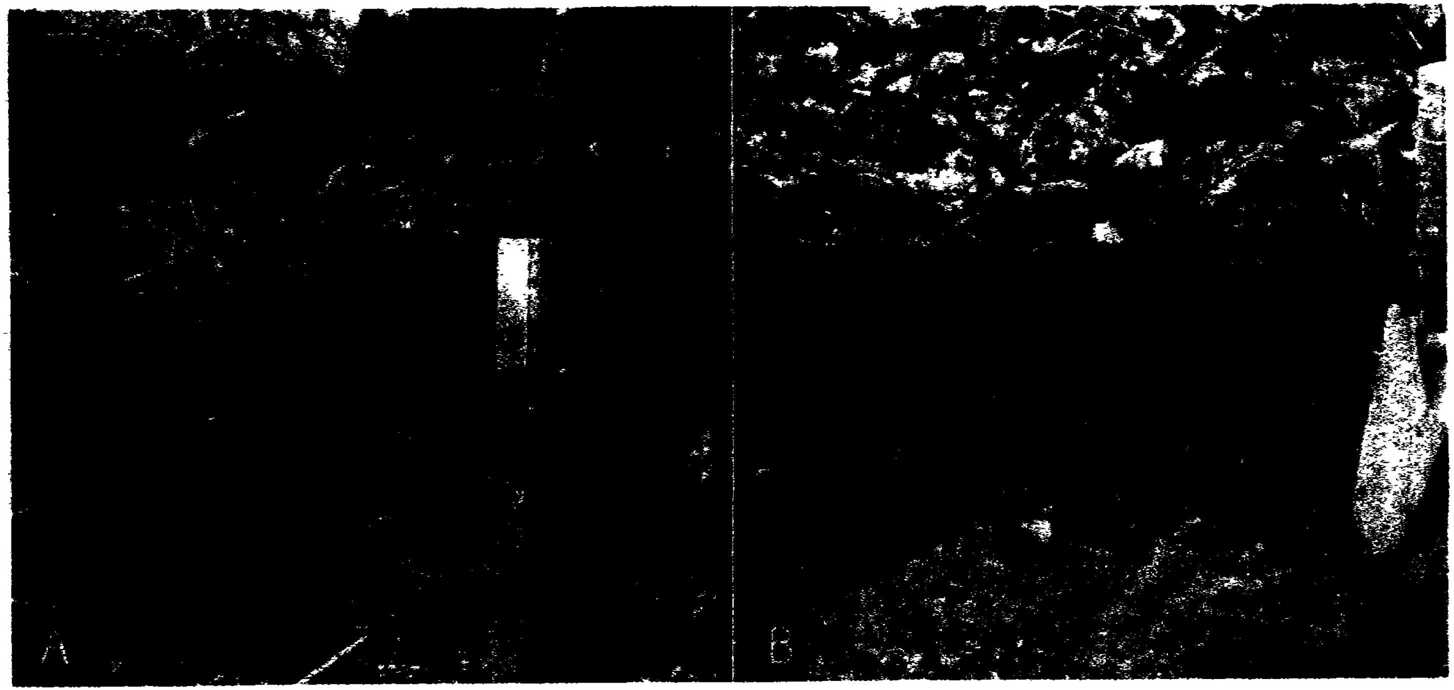
Disease Control:

Rots due to fungi were found important in certain tree species. Every sawyer stated that a heart rot of red oak is very common and destructive. Trunk rots are also very common in beech, and in many cases the top limbs are also partially decayed. In grazed stands the exposed roots of sugar maple and beech are infected very frequently by rots. Losses resulting from these causes can be minimized mainly by the removal of the cull and over-mature trees in the initial cuttings, thus saving only the best trees for the final crop, and also by the elimination of grazing.

SUMMARY AND RECOMMENDATIONS

Auglaize County is mainly an agricultural unit in which the woodlands are of secondary importance in regard to value and land coverage. Originally, however, this region was almost entirely covered with swamp forests. Cutting, grazing, and drainage are the most important factors which have brought about the woodland conditions of today.

Only 6.3 per cent of the total area of the county is now forested. The woodlands, which are usually a section of a farm, are generally small units, the average size of which is 10.9 acres. Of the total woodland area, only 5.4 per cent is comparable to the original stands in composition and structure. Severe cutting characterizes a large number of the woodlands as shown by the fact that 34 per



Effect of Livestock Grazing on Forest Soil.

A—A firm mull, characteristic of heavily grazed open forest stands, the surface horizon of this profile is relatively non-porous, very compact, and difficult to distinguish from the layers beneath. Very few earthworms were found, and the roots were small and very scattered.

B—A coarse mull, characteristic of ungrazed, well-managed woodlands. A loose litter layer overlies the mull which comprises the surface horizon of the profile. It is a dark, porous, granular layer, two to three inches in thickness, with a large earthworm population and an abundance of roots scattered throughout.

cent of the total forested area is composed of young growth with a few scattered large trees, and 17 per cent is open park grazed stands.

For the county as a whole, the oaks as a group are the most important vegetation in the woodlands in regard to value and cover. However, one of the most noticeable observations made in this survey was that there is only a small number of trees of this genus in the reproduction of all types. The important individual tree species according to the total number of stems and total basal area are the American elm and shagbark hickory. Both species are present in all types and are generally dominant in the reproduction. Sugar maple and white ash are valuable species which also occur throughout the county.

The values of the forest products and of the wood-using industries are important economic factors within the county. For the average farm, fuelwood is the most important woodland product; saw timber and posts are of secondary importance.

There is no doubt that it is possible to better the conditions of the farm woodlands and also to increase their productivity and value. In order to accomplish this, the following general recommendations are made:

1. Woodland owners should be shown the value of highly productive stands and the methods of obtaining such stands.
2. The farmers who sell timber should have a knowledge of the methods of estimating volume and the best methods of marking and cutting.
3. The sawmill owners who buy and cut the timber should be fully informed of the value of continuous yields.
4. Grazing of woodlands should be eliminated.

LITERATURE CITED

(1) **Diller, O. D., et al.** *Ohio's Forest Resources.* Ohio Agr. Exp. Sta., Forestry Pub. 76, 1944.

(2) **Gordon, R. B.** *The Primary Forest Types of the East Central States.* Ph.D. Dissertation, Ohio State University, 1931.

(3) **Sitterley, J. H.,** and **Falconer, J. I.** *Better Land Utilization for Ohio.* Ohio State University and Ohio Agr. Exp. Sta. Dept. of Rural Economics Bul. 108. 1938.

(4) **Williamson, G. W.** *History of Western Ohio and Auglaize County.* Press of W. M. Linn and Sons, Columbus, Ohio. 1905.

(5) **Winchell, N. H.** *Report on the Geology of Auglaize County.* Report of the Geological Survey of Ohio. Vol. II, Geology and Palaeontology. Nevins and Meyers, State Printers, Columbus, Ohio. 1874.

Clouds and Weather Phenomena

The revised edition of this booklet, first published in 1926, contains 42 cloud photographs and a brief text of 24 pages. This little volume is likely to appeal to those who have more than passing interest in the more spectacular atmospheric phenomena such as cloud types, sunsets, rainbows, coronae and halos, and mirages. The author "has written for those not wishing to make a deep study of meteorological matter, yet who take an interest in the changing pageant of the sky."

Chinook winds, tornadoes, cyclones, northern lights, looming and lightning are some of the phenomena that could well have been included under the title without exceeding the author's objective of simplicity.—*John N. Wolfe.*

Clouds and Weather Phenomena, by C. J. P. Cave. Cambridge, at the University Press; New York, The Macmillan Co., $1.75.

A STUDY OF THE ASCORBIC ACID CONTENT OF THE DIET COMMONLY PRESCRIBED FOR PATIENTS WITH GASTRIC ULCERS[1]

MARGARET M. DUNNIGAN, MARTHA N. LEWIS AND M. R. SHETLER,
The Ohio State University Hospital and the Department of Agricultural Chemistry,
The Ohio State University, Columbus, Ohio

The diet prescribed for patients suffering with gastric ulcer is one which must be followed over a period of months or years; therefore it is quite important that such a diet supply all of the essentials for good nutrition. A study of the literature reveals that, while special diet restrictions advised because of the presence of gastric ulcer have resulted in improvement of the ulcerous condition, these restrictions have in many cases resulted in definite deficiency states. It has long been recognized that the usual diets prescribed for gastric or duodenal ulcers are often deficient in ascorbic acid (7, 21). Cases have been reported (2, 5, 18, 22) of the development of scurvy in patients who followed such a diet. At present, moreover, it has been noted that early "prescorbutic" states in such cases are of frequent occurrence (1, 3, 8, 9, 10, 11, 13, 14, 15, 19). Further, the relationship of ascorbic acid to collagen formation (2, 3, 4) and consequently to wound healing (12), and to capillary fragility (6), may indicate that this vitamin is important in the healing of the ulcers although it is unlikely that ascorbic acid deficiency is a definite etiological factor in producing peptic ulcer in man (17, 19). Thus it would appear that the presence of a superimposed ascorbic acid deficiency state in patients with peptic ulcer would be extremely detrimental Consequently this study was undertaken with two objects in view: first, to determine the ascorbic acid content of the ulcer diet as it was being served at the hospital; and second, to suggest a practical means of maintaining an adequate vitamin C intake in the diet of the ulcer patient.

PROCEDURE

The menu for the prescribed diet was written daily by the therapeutic dietitian and served from the floor diet kitchen in the usual manner. In general, the typical pattern of the diet was as follows:

BREAKFAST	LUNCH	SUPPER
Fruit	Protein Dish	Soup or Vegetable
Cereal with Cream and Sugar	Potato	Egg, Cottage Cheese
Egg	Vegetable	or Baked Potato
Toast with Butter	Toast with Butter	Toast with Butter
Milk	Dessert	Dessert
	Milk	Milk

At 10 A. M., 2 and 8 P. M., a glass of milk is given.

This diet is characterized by its bland and non-irritating foods Any tender meats such as beef, lamb, chicken, ground or scraped beef, liver, tender fish or sweetbreads and cream or cottage cheese and eggs are given. Cereals as Farina, white or fine whole wheat bread, noodles, and rice are permitted. All coarse vegetables such as corn, green beans, peas, and lima beans are strained and other vegetables as potatoes, spinach, asparagus, carrots are given if well cooked. Orange, grapefruit, and tomato juices, soft stewed fruits, peaches, sieved pears, apricots, and prunes are allowed in addition to simple desserts as custard, junket, jello, ice cream, and sponge cake. Beverages such as milk and eggnog are used frequently, and weak coffee, cocoa, or chocolate milk are sometimes permitted. Each item of food was weighed as served and aliquot samples were collected. Analyses were made 15 to 20 minutes after each collection except for the supper meal, in which case metaphosphoric suspensions were made in the usual manner, placed in the refrigerator at 5° C., and the analyses completed the following morning.

---

[1] Condensed from a thesis submitted to the Graduate School in partial fulfillment of the requirements for the degree of Master of Science at The Ohio State University.

The estimation of ascorbic acid was made by a modified Roe and Kuether method (20). This method gives directly a determination of the total ascorbic acid, and encounters no difficulties with pigmented food extracts.

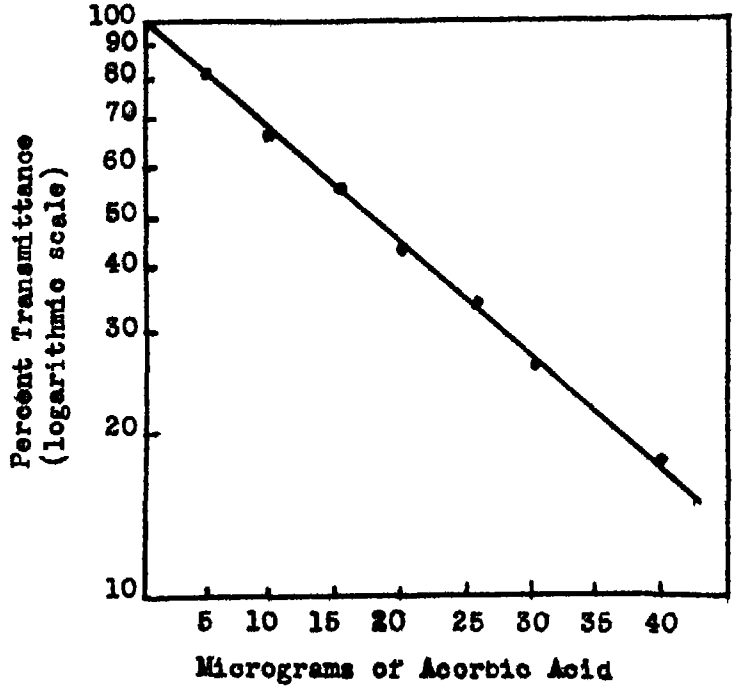


FIG. 1. Absorption Curve of 2, 4-dinitrophenonydrazine Derivative of Ascorbic Acid Using Reagent Blank as Reference Solution.

One to ten grams of the sample (a weight which when diluted properly would contain 5 to 40 gammas of ascorbic acid per milliliter) were weighed into the bowl of the Waring Blendor. Fifty or one hundred milliliters of 1% metaphosphoric acid were then added and the sample mixed at high speed for approximately three minutes. The mixture was transferred to a volumetric flask (100 ml. or 200 ml.) and made up to volume with 8% trichloroacetic acid. For each 100 cc. of the diluted sample approximately one teaspoonful (1.5 gm.) of acid washed norite was added and the mixture shaken vigorously.

Five cubic centimeters of the norite filtrate were placed in each of two matched photoelectric colorimeter tubes. When a volume smaller than 5 cc. was used, the quantity was made up to 5 cc. with 4% trichloroacetic acid. One drop of 10% thiourea solution was added to each tube. One tube was held in reserve for a blank and to the other tube 2 cc. of 2, 4-dinitrophenylhydrazine was added. The latter tube was placed in a water bath at 37° C. The bath was well equipped by thermostat to maintain a constant temperature. The tube was kept immersed in the water bath for exactly three hours. It was removed and placed in a beaker of ice water containing generous quantities of ice. The blank tube was placed in the water also. To each of these tubes while in the ice water bath, were added very slowly 5 cc. of 85% sulphuric acid. The sulphuric acid was added from a burette a drop at a time, a step which required about one minute. It is very important not to allow the temperature of the solution to be raised appreciably, as this brings about a charring of the sugars or other organic matter and thus a positive error would be introduced. Finally, 1 cc. of 2, 4-dinitrophenylhydrazine was added to the blank tube. Both tubes were shaken thoroughly under the ice water to obtain complete mixing and were then removed to a rack. After thirty minutes the tubes were wiped clean and dry and read in a Coleman 10 S spectrophotometer using light with a wave length of 510 mu since in preliminary work an absorption curve (Fig. 1) showed an absorption band at 510–520.

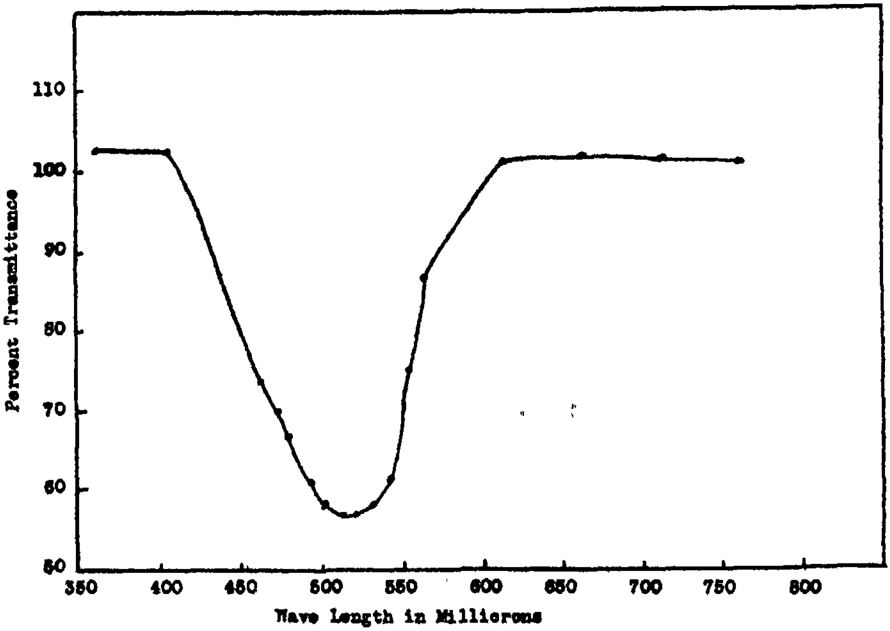


FIG. 2. Calibration Curve Made at 510 Millicrons.

A calibration curve was constructed using standard solutions of ascorbic acid varying from 5 to 40 gammas in 4% trichloroacetic acid. These solutions were treated with norite, filtered, and the determinations made in exactly the same way as described above. The readings of the known solutions were then plotted on semi-log paper, per cent transmittance against concentration (Fig. 2). Readings of the unknown solutions were determined, referred to the curve, and the ascorbic acid content computed.

In some cases simultaneous determinations on each item of food were made by a modified Tillman's (16) method; these results were found to agree closely with those obtained by the colorimetric method; however, in most cases, slightly higher results were obtained by the colorimetric method. This is to be expected since the colorimetric method gives an estimation of total ascorbic acid, while the method of Tillman determines only the reduced form. The vitamin C contents of individual foods as analyzed are recorded in Table I and the total ascorbic acid content of each day's diet for sixteen days are recorded in Table II.

TABLE I

VITAMIN C CONTENT OF FOODS ANALYZED

Food	Method of Preparation	Variety	No. of Times on Menu	Av. milligrams of Vitamin C per 100 grams
Apples	Steamed, unpeeled	Jonathan	1	3.1
	Sauce	Winesap	1	1.25
	Juice (commercially prepared)		1	0.00
Apricots	Juice (commercially canned)		2	0.00
Grapefruit	Juice (commercially) canned)		1	32.5
Lemons	Lemonade (1 pt. of lemon juice to 1 gal. of water)	California	2	7.80
	Pudding		1	0.00
Loganberries	Juice (commercially canned)		1	0.00
Pears	Commercially canned	Bartlett	3	1.49
Oranges	Juice (prepared the night before, sealed and placed in refrigerator)	Valencia	8	37.50
	Orangeade (approx. one-half orange juice and one-half water)	Valencia	2	16.00
Asparagus	Steamed to warm (commercially canned)		3	18.70
	Puree (commercially canned, then warmed when served)		1	15.0
	Soup (homemade, one-third asparagus puree and two-thirds milk)		1	4.38
Beets	Fresh, steamed, small, whole		2	2.40
	Whole, canned, steamed to warm		2	3.10
Carrots	Puree (canned, warmed before served)		2	5.30
	Strips, (fresh,steamed, then buttered)		2	3.05
	Cubes, (fresh, steamed, buttered)		1	2.8
Green Beans	Puree (commercially canned)		1	6.0
Peas	Puree (commercially canned, heated before serving)		2	5.75
	Soup (homemade, one-third pea puree, two-thirds milk)		2	2.95

TABLE I—(*Continued*)

Food	Method of Preparation	Variety	No. of Times on Menu	Av. milligrams of Vitamin C per 100 grams
Potato, Sweet..	Mashed.	Nancy Hall..	1	12.0
	Steamed, candied...	Nancy Hall.	1	19.5
Potato, White..	Steamed, unpeeled.......	Idaho........	1	15 5
	Steamed, peeled, buttered.	Red Russets.........	1	13 0
	Baked............	Idaho Russet......	4	11 31
	Escalloped..	Red Russets......	1	10 0
	Mashed......	Red Russets.........	2	9 1
	Mashed....	Bliss Triumphs.....	1	8 1
	Creamed.....	Bliss Triumphs......	1	6 7
	Baked, stuffed	Idaho	1	2 2
Spinach......	Soup (homemade, one-third spinach puree and two-thirds milk)....	....	1	1 00
Squash.....	Mashed, frozen.	Winter	2	7 29
Tomatoes	Juice (commerci'ly canned)	....	4	11 25
	Soup (commerci'ly canned)	....	1	3 55
	Soup (homemade, approx. two-thirds milk and one-third canned tomato puree)	.....	2	4 38
Cream......	Pasteurized..	....	5	0 30
Ice Cream ..	Commercial (vanilla)....	......	3	0 53
Liver.....	Baked.	Beef.......	1	16 20
	Loaf (with mashed potato topping)........	Beef	1	7.00
Milk....	Pasteurized...........	....	5	1 57

TABLE II

ASCORBIC ACID IN THE DIET OF STOMACH ULCER PATIENTS

Day	Total Ascorbic Acid	Total Ascorbic Acid less Orange, Grapefruit and Tomato Juices	Total Ascorbic Acid less Orange, Grapefruit and Tomato Juice, plus 3 ounces of Orange Juice
1	152	25	60
2	99	41	76
3	125	41	76
4	34	38	73
5	142	39	74
6	75	43	78
7	64	50	85
8	40	41	76
9	31	30	65
10	89	48	83
11	142	56	91
12	61	39	74
13	39	43	78
14	45	49	84
15	100	36	71
16	117	48	83

DISCUSSION

Examination of Table II reveals that four days fell in the 25–40 milligram range, four days fell in the 40–75 milligram group and eight days reached the level 75–100 milligrams, usually considered necessary for body saturation. Also it may be noted that with the omission of orange, grapefruit and tomato juice (Table II) all of the days fell below the 60 milligram level. On the other hand, the addition of three ounces of orange juice to each day's diet would adequately correct this condition.

CONCLUSIONS

The amount of ascorbic acid furnished by the fruits and vegetables used in the ulcer diet other than orange, grapefruit or tomato can be relied upon to contribute only a small part of the daily need. From the results obtained, it can be seen that the required standard of ascorbic acid necessary for body saturation (75–100 milligrams) cannot be assured in the routine ulcer diet without the daily use of more than three ounces of orange juice, or its equivalent in other citrus fruit juices.

BIBLIOGRAPHY

(1) **Archer, H.** and **Graham, G.** The Subscurvy State in Relation to Gastric and Duodenal Ulcer. Lancet, 231: 364, 1936.

(2) **Barling, B.** Scurvy during Treatment for Gastric Ulcer. Brit. Med. J., 1: 358, 1935.

(3) **Bourne, G.** Vitamin C Deficiency in Peptic Ulceration Estimated by the Capillary Resistance Test. Brit. Med. J., 1: 560, 1938.

(4) **Dalldorf, G.** The Pathology of Vitamin C Deficiency. J. Am. Med. Assoc., 111: 1376, 1938.

(5) **Davidson, P.** The Development of Deficiency Disease During Therapeutic Diets. J. Am. Med. Assoc., 90: 1014, 1928.

(6) **Field, H., Robinson, W.,** and **Melnick, D.** Vitamins in Peptic Ulcers. Ann. Int. Med., 14: 588, 1940.

(7) **Green, C.** The Adequacy of Diets Used in the Treatment of Peptic Ulcer. J. Am. Dietet. A., 17: 570, 1941.

(8) **Harris, L. J.** A Programme for Nutrition Surveys. Lancet, 230: 966, 1936.

(9) **Harris, L. J., Abbasy, M. A., Ray, S. N.,** and **Marrack, J. R.** Diagnosis of Vitamin C Subnutrition by Urine Analysis. Lancet, 229: 1399, 1935.

(10) **Harris, L. J., Abbasy, M. A.** and **Yudkin, J.** The Vitamin C Reserves of Subjects of the Voluntary Hospital Class. Lancet, 230: 1488, 1936.

(11) **Ingalls, T.,** and **Warren, H.** Asymptomatic Scurvy, Its Relation to Wound Healing and Its Incidence in Patients with Peptic Ulcer. New Eng. J. M., 217: 443, 1937.

(12) **Lanman, T.** and **Ingalls, T.** Vitamin C Deficiency and Wound Healing. Ann. Surg., 105: 616, 1937.

(13) **Lazarus, S.** Vitamin C Nutrition in Cases of Haematemesis and Melaena. Brit. Med. J., 2: 1101, 1937.

(14) **Ludden, J., Flexner, J.,** and **Wright, I.** Studies on the Ascorbic Acid Deficiency in Gastric Disease, Incidence, Diagnosis and Treatment. Am. J. Digest. Dis. and Nutrition, 8: 249, 1941.

(15) **Lund, C.** Ascorbic Acid Deficiency Associated with Gastric Lesions. New Eng. J. M., 227: 247, 1942.

(16) **Mack, G. L.,** and **Tressler, D. K.** Vitamin C in Vegetables. A Critical Investigation of the Tillmans Method for the Determination of Ascorbic Acid. J. Biol. Chem., 118: 735, 1937.

(17) **McCarrison, R.** Some Surgical Aspects of Faulty Nutrition. Lancet, 220: 1151, 1931.

(18) **Platt, R.** Scurvy as a Result of Dietetic Treatment. Lancet, 231: 366, 1936.

(19) **Portnoy, B.,** and **Wilkinson, J.** Vitamin C Deficiency in Peptic Ulceration and Haematemesis. Brit. Med. J., 1: 554, 1938.

(20) **Roe, J. H.,** and **Kuether, C. A.** The Determination of Ascorbic Acid in Whole Blood and Urine Through the 2, 4 Dinitrophenylhydrazine Derivative of Dehydroascorbic Acid. J. Biol. Chem., 147: 399, 1943.

(21) **Troutt, L.** Quality Studies of Therapeutic Diets: The Ulcer Diet. J. Am. Dietet. A., 8: 25, 1932.

(22) **Wood, P.,** and **Melb, M. B.** A Case of Adult Scurvy. Lancet, 229: 1405, 1935.

LIST OF CHRYSOMELIDAE (COLEOPTERA) KNOWN TO OCCUR IN OHIO[1]

JOHN H. HUGHES,
University of Minnesota,
St. Paul, Minnesota

Specific investigation of the leaf beetles of the family *Chrysomelidae* was begun by the writer in June 1937 while a graduate student at Ohio University, Athens, Ohio. Records to July 1939, supplemented by data from other sources, were used in a Master's Thesis at Ohio University, Athens, Ohio, in August 1939 (unpublished). This list is based on the above mentioned data plus all records obtained by October 1940.

The family *Chrysomelidae*, which is world-wide in its distribution, is one of the largest known families of Coleoptera. Leng (1920) lists more than 1000 species and varieties for America north of Mexico. Records for 332 species and varieties for New York State are given by Leonard et al. (1926). Blatchley (1910) gives 266 species and varieties for Indiana. In 1902 and with additions in 1906, Dury published a list of Coleoptera of the Cincinnati Region (mainly Hamilton County) which included 163 species and varieties of *Chrysomelidae* for Ohio. This is the only other extensive published list for the State.

The present list records 298 species and varieties for Ohio, of which the writer has personally collected 192. Distribution records for other states indicate that an additional 112, for which we have no Ohio records at present, may occur in the state. Species are considered possible for Ohio when they have been reported from an adjacent state, from Western New York (Leonard et al., 1926) or when Ohio is located between two or more known points of occurrence. The total known and possible species and varieties for Ohio may be more than 400.

The synonymy and arrangement follow Leng (1920). The number of specimens of each species examined is given in parentheses. Records for species and varieties are given by counties. When the county is not known, "Ohio" is used instead. The earliest and latest known dates of the year on which each species was collected are recorded. When a record is based on published literature alone, it is accompanied by an explanatory note, except for some records taken from Dury (1902, 1906) in which case "Hamilton (CSNH)" is employed.

Abbreviations (in parentheses) for the sources of material are used as follows:

CM......Cleveland Museum of Natural History, Cleveland, Ohio.
CSNH....*Cincinnati Society of Natural History, Cincinnati, Ohio.*
JHH.....Personal Collection of the Writer.
OSM.....Ohio State Museum, Columbus, Ohio.
OSU......Ohio State University, Columbus, Ohio.
OU.......Ohio University, Athens, Ohio.
RML.....Ralph M. Leonard, Athens, Ohio.

When the abbreviations are accompanied by a question mark, the species is doubtfully recorded for that collection.

I wish to express my appreciation to Dr. William C. Stehr, Ohio University, Athens, Ohio, for guidance in this study and for use of the Ohio University collections. I am also grateful to Dr. John W. Aldrich, Cleveland Museum of Natural History; Mr. Ralph M. Dury, Cincinnati Society of Natural History; Mr. Edward S. Thomas, Ohio State Museum; Dr. J. N. Knull, Ohio State University; and to Mr. Ralph M. Leonard, Athens, Ohio, for making collections of *Chrysomelidae* available for this study.

---

[1] Paper No. 14 from the Department of Zoology, Ohio University, Athens, Ohio.

Family CHRYSOMELIDAE

Subfamily DONACIINAE

Genus **Donacia** Fab.

D. **piscatrix** Lac. (39) Erie, Holmes, Licking, Vinton. May 30–Sept. 21. (JHH, OSM, OSU).
D. **palmata** Oliv. (9) Ashtabula, Erie, Morgan, Ottawa, Vinton. June–Sept. 21. (CSNH, JHH, OSU, OU).
D. **hypoleuca** Lac. (1) Erie, Knox. July–Aug. 6. (CM).
The Knox County record for July was taken from Schaeffer (1925).
D. **cincticornis** Newn. (26) Athens, Erie, Knox, Ottawa. May 25–Aug. 6. (OSM, OSU, OU).
D. **proxima** Kby. (6) Erie. July 11–Aug. 8. (OSU).
D. **quadricollis** Say (3) Erie. July 6–Aug. 1. (OSU).
D. **subtilis** Kunze (307) Auglaize, Erie, Fairfield, Fulton, Geauga, Hamilton, Jackson, Licking, Logan, Lucas, Medina, Ottawa, Pickaway, Portage, Summit, Vinton, Wayne. May 17–Sept. 23. (CM, CSNH, JHH, OSM, OSU, OU).
D. **aequalis** Say (8) Erie, Hamilton, Lawrence, Summit. April 24–July 5. (CSNH, OSM, OSU).
D. **rufa** Say (14) Hamilton, Hocking. April 17–May 30. (CSNH, OSU).
D. **sulcicollis** Lac. (32) Hamilton, Jackson, Medina, Summit. April 24–May 31. (CM, CSNH, JHH, OSM, OU).
D. **flavipes** Kby. (8) Champaign, Summit, Wayne. May 18–June 12. (CSNH, OSM, OSU).
D. **metallica** Ahr. (38) Cuyahoga, Hamilton, Medina, Summit. May 12–June 13. (CM, CSNH, OSM, OSU).
D. **pusilla** Say (5) Erie. July. (CSNH, OSU).

Other species of the Genus *Donacia* possible for Ohio: *D. texana* var. *minor* Schffr., *rufescens* Lac., *cincticornis* var. *tenuis* Schffr., *hirticollis* Kby., *pubescens* Lec., *rugosa* Lec., *biimpressa* Melsh., *biimpressa* var. *limonia* Schffr., *porosicollis* Lac., *subtilis* var. *fulgens* Lec., *tuberculifrons* Schffr., *megacornis* Blatch., *pubicollis* Schffr., *harrisi* Lec., *nitida* Germ., *emarginata* Kby., *diversa* Schffr., *wallisi* Schffr.

Subfamily ORSODACNINAE

Genus **Orsodacne** Latr.

O. **atra** (Ahr.) (20) Athens, Franklin, Gallia, Hamilton, Hocking, Jackson, Meigs, Summit, Wayne. Mar. 16–May 20. (CM, CSNH, OSM, OSU, OU).
O. **atra** var. **hepatica** Say (2) Cuyahoga, Hocking. May 9–May 16. (CM, OSU).
O. **atra** var. **trivittata** Lac. (1) Hamilton. (CSNH).
O. **atra** var. **vittata** Say (12) Athens, Gallia, Hocking, Jackson, Meigs. Mar. 17–May 20. (OSM, OSU, OU).

Genus **Syneta** Lac.

S. **ferruginea** (Germ.) (25) Athens, Clark, Greene, Hamilton, Hocking, Pickaway, Wayne. April 26–June 19. (CSNH, OSU, OU).

Genus **Zeugophora** Kunze

Species of the Genus *Zeugophora* possible for Ohio: *Z. kirbyi* Baly, *reineckei* Grote, *scutellaris* Suffr., *consanguinea* Cr., *varians* Cr.

Subfamily CRIOCERINAE

Genus **Crioceris** Geoffr.

C. **asparagi** (L.) (221) Athens, Cuyahoga, Erie, Franklin, Guernsey, Hamilton, Hocking, Jackson, Ottawa, Perry. May 9–Sept. 24. (CM, CSNH, JHH, OSM, OSU, OU, RML).
C. **duodecimpunctata** (L.) (66) Ashtabula, Athens, Erie, Guernsey, Jackson, Lucas, Muskingum, Perry. May 19–Sept. 17. (CM, JHH, OSM, OSU, OU).

Genus **Lema** Fab.

L. **brunnicollis** Lac. (2) Fairfield, Franklin. May 11–July. (JHH, OSU).
L. **collaris** Say (16) Erie, Hamilton. May 30–July 10. (CSNH, OSU).
L. **trilineata** (Oliv.) (106) Adams, Ashtabula, Athens, Cuyahoga, Darke, Erie, Fairfield, Franklin, Hamilton, Hocking, Holmes, Jackson, Lake, Lucas, Meigs, Ottawa, Pickaway, Pike, Portage, Summit, Vinton, Washington. May 16–Oct. 9. (CM, CSNH, JHH, OSM, OSU, OU, RML).
L. **sexpunctata** Oliv. (264) Athens, Meigs. June 16–Nov. 10. (JHH, OU, RML).
L. **sexpunctata** var. **albini** Lac. (53) Athens, Meigs. June 14–Nov. 1. (JHH, OU, RML).

Other species of the Genus *Lema* possible for Ohio: *L. sayi* Cr., *palustris* Blatch.

Subfamily CLYTRINAE

Genus **Anomoea** Lac.

A. **laticlavia** Forst. (103) Athens, Fairfield, Franklin, Fulton, Hamilton, Hocking, Jackson, Lawrence, Licking, Logan, Lucas, Meigs, Morrow, Muskingum, Ottawa, Tuscarawas, Vinton. May 18–July 10. (CSNH, JHH, OSM, OSU, OU, RML).

Genus **Coscinoptera** Lac.

C. **dominicana** (Fab.) (73) Adams, Athens, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Meigs, Vinton. May 19–Aug. 17. (CSNH, JHH, OSM, OSU, OU).

Genus **Babia** Lac.

B. **quadriguttata** (Oliv.) (97) Athens, Champaign, Clark, Franklin, Greene, Hamilton, Hocking, Jackson, Meigs, Ottawa, Scioto, Vinton. May 22–Oct. 19. (CSNH, JHH, OSM, OSU, OU).

Genus **Saxinis** Lac.

S. **omogera** Lac. (23) Adams, Athens, Gallia, Hamilton, Jackson, Lucas, Meigs, Vinton, May 22–Aug. 9. (CSNH, JHH, OSU, OU, RML).

Subfamily FULCIDACINAE

Genus **Arthrochlamys** Ihering

A. **gibbosa** (Fab.) (73) Adams, Athens, Clark, Clermont, Cuyahoga, Fairfield, Franklin, Gallia, Greene, Hamilton, Hocking, Jackson, Lawrence, Medina, Meigs, Pike, Scioto, Vinton. May 1–Oct. 3. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Other species of the Genus *Arthrochlamys* possible for Ohio: *A. cribripennis* Lec.

Genus **Exema** Lac.

E. **gibber** (Oliv.) (69) Adams, Athens, Champaign, Fairfield, Franklin, Hamilton, Jackson, Lawrence, Meigs, Morgan, Pike, Ross, Vinton. May 10–Oct. 13. (CSNH, JHH, OSM, OSU, OU, RML).

E. **conspersa** (Mann.) (3) Hamilton. June 12–June 27. (CSNH).

E. **conspersa** var. **dispar** Lac. (238) Adams, Ashland, Ashtabula, Athens, Cuyahoga, Gallia, Hamilton, Hocking, Jackson, Lawrence, Meigs, Pike, Portage, Scioto, Summit, Vinton. May 22–Sept. 26. (CM, CSNH, JHH, RML).

Subfamily CRYPTOCEPHALINAE

Genus **Griburius** Hald.

G. **larvatus** (Newn.) Hamilton. (CSNH).

G. **scutellaris** (Fab.) (5) Fairfield, Hamilton, Jackson, Lucas, Vinton. June 9–July 7. (CSNH, JHH, OU).

G. **equestris** (Oliv.) (3) Hamilton, Lawrence. May 29. (CSNH, OSU). The Hamilton record by Charles Dury (CSNH) is given in Blatchley (1910).

Genus **Pachybrachys** Redt.

P. **pubescens** (Oliv.) (13) Hamilton, Hocking, Jackson. May 17–June 9. (CSNH, JHH, OSU).

P. **lodingi** Bowd. (1) Hamilton. (CSNH).

P. **sobrinus** Hald. (7) Athens, Hamilton, Lawrence, Meigs, Scioto. May 29–Aug. 26 (CSNH, JHH, OSU).

P. **femoratus** (Oliv.) (4) Athens, Lucas. June 23–July 7. (OU).

P. **subfasciatus** Lec. (24) Athens, Clark, Greene, Hamilton, Hocking. May 14–July 2. (CSNH, JHH, OSU, OU).

P. **atomarius** (Melsh.) (40) Athens, Hamilton, Hocking, Jackson, Vinton. May 22–Aug. 17. (CSNH, JHH, OU).

P. **roboris** Fall (2) Hamilton. June 27–July 7. (CSNH).

P. **spumarius** Suffr. (1) Athens. July 9. (JHH).

P. **tridens** (Melsh.) (31) Athens, Auglaize, Fairfield, Hamilton, Vinton. May 22–Aug. 17. (CSNH, JHH).

P. **bivittatus** (Say) (53) Athens, Cuyahoga, Erie, Franklin, Hamilton, Jackson, Lake, Licking, Ottawa, Preble, Washington. May 18–Sept. 21. (CM, CSNH, JHH, OSM, OSU).

P. **litigiosus** Suffr. (8) Athens, Jackson, Vinton. June 16–July 21. (JHH).

P. **othonus** (Say) (18) Ashland, Athens, Cuyahoga, Gallia, Hamilton, Jackson, Summit, Vinton, Warren, Wood. June 4–July 24. (CM, CSNH, JHH, OSU, OU).

P. **carbonarius** Hald. (2) Athens, Hocking. June 7–June 28. (JHH, OSM).

P. **viduatus** (Fab.) (1) Hamilton. (CSNH).

P. **m-nigrum** (Melsh.) (2) Lawrence, Vinton. Aug. 17–Aug. 23. (JHH).

P. **trinotatus** (Melsh.) (48) Athens, Cuyahoga, Fairfield, Gallia, Geauga, Hamilton, Jackson, Meigs, Portage, Vinton. June 29–Sept. 4. (CM, CSNH, JHH, OU).

P. **confusus** Bowd. (16) Athens, Hocking, Jackson, Vinton. July 4–Aug. 19. (JHH).

P. **luridus** (Fab.) (14) Athens, Hamilton, Jackson, Lucas, Meigs, Vinton, Wood. May 30–July 7. (CM, CSNH, JHH, OU, RML).

P. **luridus** var. **nigrinus** Blatch. (1) Ashland. June 24. (CM).

P. **dilatatus** Suffr. (8) Athens, Fairfield, Hamilton, Jackson, Meigs. May 18–July 2. (CSNH, JHH, OU).

P. **hepaticus** (Melsh.) (14) Athens, Hamilton, Jackson, Warren. June 10 to 12–July 7. (CSNH, JHH).

Other species of the Genus *Pachybrachys* possible for Ohio: *P. abdominalis* (Say), *pectoralis* (Melsh.), *calcaratus* Fall, *peccans* Suffr., *tridens* var. *flavicornis* (Melsh.), *obsoletus* Suffr., *praeclarus* Weise, *autolycus* Fall, *autolycus* var. *difficilis* Fall, *pulvinatus* Suffr.

Genus **Monachulus** Leng

M. **ater** (Hald.) (43) Athens, Fairfield, Fulton, Gallia, Hamilton, Hocking, Jackson, Lawrence, Vinton. June 10–Sept. 3. (CSNH, JHH, OSU).

M. **saponatus** (Fab.) (89) Athens, Erie, Gallia, Hamilton, Hocking, Jackson, Lawrence, Lucas, Madison, Vinton. June 16–Sept. 3. (CSNH, JHH, OSU, OU).

M. **guerini** (Perbosc.) Hamilton. (CSNH).

Genus **Cryptocephalus** Geoffr.

C. **notatus** var. **quadrimaculatus** Say (36) Athens, Franklin, Hamilton, Hocking, Jackson, Lawrence, Meigs, Warren. May 15–July 25. (CSNH, JHH, OSM, OSU, OU, RML).

C. **quadruplex** Newn. (84) Adams, Ashland, Athens, Champaign, Cuyahoga, Darke, Franklin, Hamilton, Hocking, Jackson, Lucas, Ottawa, Vinton. May 25–Sept. 5. (CM, CSNH, JHH, OSM, OSU, OU, RML).

C. **quadruplex** var. **quadriguttulus** Suffr. (18) Athens, Erie, Hamilton, Licking. May 15–Aug. 19. (CSNH, OSU, OU).

C. **guttulatus** Oliv. (9) Adams, Athens, Hamilton, Hocking. June 13–Oct. 12. (CSNH, OSU, OU).

C. **leucomelas** Suffr. (41) Adams, Athens, Fairfield, Franklin, Hamilton, Jackson, Lucas, Montgomery, Ross, Scioto. June 21–Sept. 12. (CSNH, JHH, OSM, OSU, OU).

C. **venustus** Fab. (77) Adams, Ashland, Athens, Champaign, Gallia, Hamilton, Hocking, Jackson, Lawrence, Morgan, Ottawa, Pike, Scioto, Summit, Vinton, Warren. June 10 to 12–Sept. 3. (CM, CSNH, JHH, OSM, OSU, OU).

C. **venustus** var. **cinctipennis** Rand. (16) Ashland, Ashtabula, Athens, Auglaize, Hamilton, Hocking, Jackson, Ottawa, Vinton. June 19–Aug. 20. (CM, CSNH, JHH, OSU, OU).

C. **venustus** var. **hamatus** Melsh. (18) Ashland, Athens, Erie, Fairfield, Hamilton, Jackson, Lake, Medina, Pike, Vinton. Feb. 10–Sept. 3. (CM, CSNH, JHH, OSU, OU).

C. **venustus** var. **simplex** Hald. (38) Adams, Ashland, Athens, Gallia, Hamilton, Jackson, Lawrence, Meigs, Morgan, Vinton. June 5–Sept. 3. (CM, CSNH, JHH, OSU).

C. **incertus** Hald. (1) Hamilton. June 20. (CSNH).

C. **trivittatus** Oliv. (1) Athens. July 24. (OU).

C. **mutabilis** Melsh. (42) Adams, Athens, Erie, Fairfield, Franklin, Fulton, Hamilton, Hocking, Lawrence, Lorain, Lucas, Meigs, Vinton. June 12–Oct. 12. (CSNH, JHH, OSM, OSU).

C. **badius** Suffr. (13) Athens, Gallia, Hamilton, Pike. June 22–Aug. 18. (CSNH, JHH).

C. **schreibersi** Suffr. (5) Hocking. Oct. 10–Oct. 14. (OSU).

C. **tinctus** Lec. (4) Athens, Jackson, Lawrence. Aug. 16–Oct. 25. (JHH, OU).

Other species of the Genus *Cryptocephalus* possible for Ohio: *C. basalis* Suffr., *striatulus* Lec.

Genus **Diachus** Lec.

D. **auratus** (Fab.) (14) Adams, Athens, Fairfield, Hamilton, Lawrence, Meigs, Pike. June 4–Aug. 26. (CSNH, JHH).

D. **pallidicornis** (Suffr) (5) Hamilton. May 28–June 4. (CSNH).

D. **chlorizans** (Suffr.) (15) Hamilton, Jackson, Pike, Vinton. July 3–Aug. 19. (CSNH, JHH).

Other species of the Genus *Diachus* possible for Ohio: *D. laevis* (Hald.), *aeruginosus* Lec., *catarius* (Suffr.).

Genus **Bassareus** Hald.

B. **brunnipes** (Oliv.) (3) Adams, Cuyahoga, Hamilton. June 26–Aug. 8. (CM, CSNH?, OSU).

B. **clathratus** Melsh. (47) Athens, Hocking, Jackson, Lawrence, Ross, Vinton. June 8–Sept. 3. (JHH, RML).

B. **formosus** (Melsh.) (20) Adams, Athens, Gallia, Hamilton, Hocking, Jackson, Pike, Scioto, Vinton. June 16–Aug. 27. (CSNH, JHH, OSM, OU).
B. **formosus** var. **sulphuripennis** (Melsh.) (3) Champaign, Lucas. July 7–July 27. (OSM, OU).
B. **detritus** (Oliv.) (1) Hamilton, Jackson. Sept. 3. (CSNH, JHH).
B. **mammifer** (Newn.) (20) Athens, Clark, Erie, Greene, Hamilton, Hocking, Portage. June 14–Aug. 4. (CSNH, JHH, OSM, OSU).
B. **mammifer** var. **sellatus** Suffr. (14) Athens, Hamilton, Pickaway, Vinton. June 4–Aug. 27. (CSNH, JHH, OSM).
B. **lituratus** (Fab.) (2) Lawrence. May 26–May 29. (OSU).
B. **lituratus** var. **castus** (Melsh.) (5) Jackson. May 22–June 26. (JHH).
B. **lituratus** var. **lativittis** (Germ.) (11) Athens, Hamilton, Warren. June 10 to 12–July 7. (CSNH, JHH).
B. **lituratus** var. **recurvus** Say. (16) Hamilton. May 21–June 19. (CSNH).
B. **lituratus** var. **niger** Blatch. (10) Jackson, Licking, Vinton. May 20–June 26. (JHH, OSU).

Genus **Triachus** Lec.

Species of the Genus *Triachus* possible for Ohio: *T. atomus* (Suffr.), *vacuus* Lec.

Subfamily EUMOLPINAE

Genus **Chrysodina** Baly

C. **globosa** (Oliv.) (6) Athens, Gallia, Hocking. May 17–July 21. (JHH, OSU).

Genus **Nodonota** Lef.

N. **tristis** (Oliv.) (337) Adams, Ashtabula, Athens, Clermont, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Licking, Lucas, Meigs, Pike, Ross, Scioto, Summit, Vinton, Washington. June 5–Oct. 20. (CSNH, JHH, OSM, OSU, OU).
N. **clypealis** Horn (241) Adams, Athens, Fairfield, Hamilton, Jackson, Lawrence, Meigs, Pike, Scioto, Vinton, Washington. June 5–Sept. 1. (CSNH, JHH, OU).
N. **convexa** (Say) (1) Guernsey, Hamilton. Aug. 19. (CSNH, OSU).
N. **puncticollis** (Say) (1101) Athens, Hamilton, Hocking, Holmes, Jackson, Lucas, Vinton. May 29–Oct. 20. (CSNH, JHH, OSM, OSU, OU, RML).

Genus **Colaspis** Fab.

C. **brunnea** (Fab.) (254) Adams, Ashtabula, Athens, Cuyahoga, Fairfield, Franklin, Gallia, Holmes, Jackson, Lawrence, Lucas, Meigs, Pike, Ross, Vinton, Washington. June 10–Aug. 29. (CM, CSNH, JHH, OSM, OSU, OU, RML).
C. **brunnea** var. **flavida** Say. (1) Lucas. July 7. (OU).
C. **brunnea** var. **suilla** Fab. (4) Fulton. June 24. (OSU).

Genus **Rhabdopterus** Lef.

R. **picipes** (Oliv.) (43) Ashtabula, Athens, Gallia, Hamilton, Hocking, Holmes, Jackson, Lawrence, Meigs, Vinton. May 2–Oct. 4. (CSNH, JHH, OSM, OSU, OU, RML).

Genus **Graphops** Lec.

C. **varians** Lec. (1) "Ohio." (CSNH).
G. **pubescens** (Melsh.) (7) Adams, Athens, Hamilton, Jackson. May 16–Aug. 29. (CSNH, JHH, OU).
G. **curtipennis** (Melsh.) (1) Scioto. Aug. 29. (JHH).
G. **marcassitus** Cr. (6) Adams, Athens, Hamilton, Jackson. May 30–Aug. 26. (CSNH, JHH, OU).
G. **nebulosus** (Lec.) (2) Hamilton, Lawrence. June 1–June 25. (CSNH, OSU).

Genus **Xanthonia** Baly

X. **decemnotata** (Say) (48) Athens, Geauga, Hamilton, Hocking, Jackson, Lawrence, Madison, Vinton. May 20–Nov. 19. (CM, CSNH, JHH, OSU, OU, RML).
X. **villosula** (Melsh.) (29) Athens, Erie, Franklin, Hamilton, Lucas, Ottawa, Vinton. June 15–Aug. 17. (CSNH, JHH, OSM, OSU, OU).

Genus **Fidia** Baly

F. **viticida** Walsh (15) Adams, Athens, Erie, Lawrence, Ottawa. June 26–Aug. 26. (CSNH, JHH, OSU, OU, RML).
F. **longipes** (Melsh.) (12) Athens, Cuyahoga, Highland, Hocking, Meigs. May 15–July 28. (CM, CSNH, JHH, OSU, OU).

Genus **Metachroma** Lec.

M. angustulum Cr. (24) Erie. June 30–July 15. (OSU).
M. pallidum (Say) Hamilton. (CSNH).

Other species of the Genus *Metachroma* possible for Ohio: *M. interruptum* (Say), *parallelum* Horn, *quercatum* (Fab.).

Genus **Adoxus** Kby.

Species of the Genus *Adoxus* possible for Ohio: *A. obscurus* (L.).

Genus **Tymnes** Chap.

T. tricolor (Fab.) (37) Athens, Cuyahoga, Geauga, Hamilton, Hocking, Perry, Portage, Vinton. May 29–Aug. 15. (CM, CSNH, OSM, OSU, OU, RML).
T. violaceus Horn (1) Scioto. May 24. (OSM).
T. metasternalis Cr. (28) Athens, Champaign, Clark, Franklin, Gallia, Greene, Hamilton, Hocking, Madison. May 2–July. (CSNH, JHH, OSM, OSU, OU).

Genus **Myochrous** Er.

M. denticollis (Say) (4) Athens, Gallia, Hamilton. Mar. 24–Aug. 11. (CSNH, JHH, OU).

Genus **Glyptoscelis** Lec.

G. pubescens (Fab.) (8) Hocking. May 9–June 14. (OSU).
G. barbata (Say) (13) Athens, Clark, Greene, Hamilton, Hocking. May 22–Sept. 10. (CSNH, OSM, OSU, RML).
G. cryptica (Say) (1) Hamilton. May 20. (CSNH).

Other species of the Genus *Glyptoscelis* possible for Ohio: *G. liebecki* Blatch.

Genus **Typophorus** Er.

T. viridicyaneus (Cr.) (50) Adams, Fairfield, Hamilton, Jackson, Pike, Ross, Vinton, Washington. June 9–Aug. 29. (CSNH, JHH, OSM).

Genus **Paria** Lec.

P. canella var. **aterrima** (Oliv.) (50) Ashtabula, Athens, Cuyahoga, Fairfield, Hamilton, Hocking, Jackson, Meigs, Scioto, Vinton. April 17–Aug. 29. (CSNH, JHH, OSU, OU, RML).
P. canella var. **gilvipes** Horn (70) Adams, Ashtabula, Athens, Auglaize, Champaign, Clark, Fairfield, Franklin, Gallia, Greene, Hamilton, Hocking, Jackson, Licking, Ottawa, Pike, Vinton, Washington. Mar. 20–Nov. 22. (CSNH, JHH, OSM, OSU, OU, RML).
P. canella var. **pumila** Lec. (19) Adams, Ashtabula, Athens, Champaign, Hamilton, Hocking, Jackson, Lawrence, Meigs, Ross. April 24–Sept. 14. (CSNH, JHH, OSU, RML).
P. canella var. **quadriguttata** Lec. (35) Adams, Athens, Jackson, Lucas, Meigs, Ross, Vinton, Washington. April 28–Aug. 29. (JHH, OU).
P. canella var. **quadrinotata** (Say) (71) Adams, Ashtabula, Athens, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Licking, Logan, Meigs, Pickaway, Ross, Summit, Vinton, Washington. April 22–Oct. 15. (CSNH, JHH, OSM, OSU, OU, RML).
P. canella var. **sellata** Horn (30) Adams, Ashtabula, Franklin, Gallia, Hamilton, Jackson, Lucas, Ross, Vinton, Washington. Mar. 25–Aug. 29. (CSNH, JHH, OSU, OU).
P. canella var. **sexnotata** (Say) (12) Champaign, Clark, Greene, Hamilton, Montgomery, Ross. April 27–Aug. 29. (CSNH, JHH, OSU).
P. canella var. **thoracica** (Melsh.) (205) Adams, Ashtabula, Athens, Auglaize, Cuyahoga, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Lucas, Meigs, Montgomery, Pike, Ross, Scioto, Vinton, Washington, Wayne. May 24–Sept. 3. (CM, CSNH, JHH, OSM, OSU, OU, RML).
P. canella var. **vittata** Horn (7) Adams, Ashtabula, Athens, Jackson, Ross, Washington. May 15–Aug. 29. (CSNH, JHH [illegible]

Other species of the Genus [illegible] for Ohio: *P. canella* var. *scutellaris* Notm., *canella* var. *opacicollis* Lec., *juniper*[illegible]

Genus **Chrysochus** Redt.

C. auratus (Fab.) (424) Adams, Ashtabula, Athens, Auglaize, Cuyahoga, Erie, Fairfield, Franklin, Gallia, Geauga, Guernsey, Hamilton, Highland, Hocking, Jackson, Lawrence, Licking, Lucas, Meigs, Ottawa, Pike, Ross, Scioto, Vinton, Washington. June 8–Sept. 19. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Subfamily CHRYSOMELINAE

Genus **Prasocuris** Latr.

P. obliquata Lec. (2) Franklin, Hamilton. May 29. (CSNH, OSU).

Other species of the Genus *Prasocuris* possible for Ohio: *P. phellandrii* (L.), *vittata* (Oliv.), *ovalis* Blatch.

Genus **Labidomera** Chev.

L. clivicollis (Kby.) (71) Adams, Ashtabula, Athens, Clermont, Crawford, Cuyahoga, Erie, Fairfield, Franklin, Hamilton, Jackson, Lake, Licking, Lucas, Meigs, Miami, Ottawa, Pike, Ross, Summit. Jan. 11–Nov. 1. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Genus **Leptinotarsa** Stal

L. decemlineata (Say) (197) Adams, Ashtabula, Athens, Cuyahoga, Erie, Franklin, Hamilton, Jackson, Knox, Meigs, Monroe, Ottawa, Portage, Sandusky, Washington. April 14–Oct. 11. (CM, CSNH, JHH, OSM, OSU, OU, RML).

L. juncta (Germ.) (229) Adams, Athens, Gallia, Hamilton, Hocking, Jackson, Lawrence, Meigs, Pike, Ross, Scioto, Washington. Mar. 29–Oct. 24. (CSNH, JHH, OSM, OSU, OU, RML).

Genus **Zygogramma** Chev.

Z. suturalis (Fab.) (549) Adams, Ashtabula, Athens, Clark, Cuyahoga, Erie, Fairfield, Franklin, Gallia, Geauga, Greene, Hamilton, Hocking, Jackson, Lake, Lawrence, Licking, Logan, Marion, Medina, Meigs, Perry, Pike, Portage, Scioto, Summit, Vinton. April 14–Oct. 2. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Z. suturalis var. **casta** Rogers (20) Adams, Athens, Cuyahoga, Darke, Erie, Gallia, Hamilton, Jackson, Lawrence, Licking, Pike. May 8–Sept. 3. (CM, CSNH, JHH, OSM, OSU).

Genus **Calligrapha** Er.

C. lunata (Fab.) (1) Lucas. July 20. (OSM).

C. similis Rogers (27) Athens, Cuyahoga, Hamilton, Hocking, Jackson, Licking, Pike. May 12–Oct. 4. (CM, CSNH, JHH, OSM, OSU, OU, RML).

C. praecelsis Rogers (10) Franklin, Hamilton, Pike. May 9–Aug. 18. (CSNH, JHH, OSM, OSU).

C. elegans (Oliv.) (22) Ashtabula, Cuyahoga, Franklin, Fulton, Hamilton, Holmes. April–Sept. 6. (CM, CSNH, JHH, OSM, OSU).

C. scalaris Lec. (16) Erie, Fairfield, Hamilton, Hocking, Holmes, Jackson, Licking, Ottawa. May–Oct. 2. (CSNH, JHH, OSM, OSU).

C. philadelphica (L.) (12) Champaign, Hocking, Jackson, Licking, Lucas, Scioto. May 18–Sept. 14. (JHH, OSM, OU).

C. multipunctata (Say) (8) Ashtabula, Cuyahoga, Hamilton, Summit. May 21–Aug. 6. (CM?, CSNH).

C. multipunctata var. **bigsbyana** (Kby.) (96) Adams, Ashtabula, Athens, Champaign, Cuyahoga, Erie, Franklin, Hamilton, Highland, Huron, Jackson, Lake, Lucas, Meigs, Ottawa, Ross, Summit, Vinton, Washington, Williams. April 26–Oct. 22. (CM, CSNH, JHH, OSM, OSU, OU, RML).

C. multiguttata Stal Hamilton. (CSNH).

Other species of the Genus *Calligrapha* possible for Ohio: *C. rhoda* var. *walshiana* Blatch., *rowena* Knab.

Genus **Chrysolina** Mots.

C. flavomarginata (Say). Van Dyke (1938) examined this species from Ohio (Leng Coll.).

Other species of the Genus *Chrysolina* possible for Ohio: *C. auripennis* (Say), *subopaca* (Rogers).

Genus **Plagiodera** Redt.

Species of the Genus *Plagiodera* possible for Ohio: *P. versicolora* (Laich.).

Genus **Phaedon**

P. viridis (Melsh.) (2) Ashtabula. April. (CSNH).

Genus **Gastroidea** Hope

G. polygoni (L.) (7) Ashtabula, Auglaize, Franklin, Hamilton, Licking. April 26–Sept. 20. (CSNH, OSM, OSU).

G. cyanea Melsh. (127) Adams, Ashtabula, Athens, Fairfield, Franklin, Hamilton, Jackson, Meigs, Perry, Portage, Vinton. April 18–Aug. 20. (CM, CSNH, JHH, OSM, OSU, OU, RML).

G. cyanea var. **caesia** Rogers (3) Ashtabula, Hamilton. June 1. (CSNH, OSU).

Genus **Lina** Meg.

L. interrupta Fab. (811) Ashland, Ashtabula, Athens, Auglaize, Clermont, Cuyahoga, Erie, Fairfield, Franklin, Hamilton, Hocking, Holmes, Jackson, Licking, Logan, Lucas, Meigs, Montgomery, Morgan, Ottawa, Portage, Sandusky, Summit, Vinton, Washington. April 1–Oct. 30. (CM, CSNH, JHH, OSM, OSU, OU, RML).

L. tremulae (Fab.) (2) Ashland, Ashtabula. June 22. (OSU).

L. scripta (Fab.) (71) Adams, Ashtabula, Athens, Erie, Fairfield, Franklin, Hamilton, Lake, Licking, Lucas, Ottawa, Ross, Vinton, Washington. June 7–Aug. 29. (CSNH, JHH, OSM, OSU, OU).

L. scripta var. **confluens** Rogers (2) Lucas. July 7. (OU).

L. obsoleta Say (1) Lucas. May 5. (OSM).

Genus **Phytodecta** Kby.

Species of the Genus *Phytodecta* possible for Ohio: *P. americana* Schffr.

Genus **Phyllodecta** Kby.

P. vulgatissima (L.) Listed for Ohio by Leng (1920).

P. americana var. **pallipes** Schffr. Listed for Ohio by Leng (1920).

Other species of the Genus *Phyllodecta* possible for Ohio: *P. vitellinae* (L.), *americana* Schffr.

Subfamily GALERUCINAE

Genus **Halticidea** Horn

H. externa (Say) (2) Hamilton. June 13. (CSNH, OSU).

Genus **Trirhabda** Lec.

T. virgata Lec. (147) Cuyahoga, Erie, Fairfield, Franklin, Hamilton, Huron, Jackson, Lake, Ottawa, Summit. June 26–Sept. 20. (CM, CSNH, JHH, OSM, OSU, OU).

T. canadensis (Kby.) (19) Cuyahoga, Erie, Lucas, Ottawa. June 12–Aug. 15. (JHH, OSU, OU).

Other species of the Genus *Trirhabda* possible for Ohio: *T. borealis* Blake.

Genus **Galerucella** Cr.

G. americana (Fab.) (3) Adams. Aug. 26. (JHH).

G. cribrata (Lec.) (211) Ashtabula, Athens, Champaign, Clark, Darke, Fairfield, Gallia, Greene, Hocking, Jackson, Lake, Lawrence, Lucas, Meigs, Pike, Portage, Ross, Vinton. May 8–Oct. 13. (CM, JHH, OSM, OSU, OU, RML).

G. sexvittata (Lec.) (323) Athens, Gallia, Hamilton, Jackson, Meigs, Pike, Portage, Vinton. May 19–Sept. 24. (CM, CSNH, JHH, OU, RML).

G. cavicollis (Lec.) (18) Ashtabula, Lucas, Ross, Vinton, Washington. June 2–Aug. 29. (JHH, OSU, OU).

G. rufosanguinea (Say) (1) Portage. July 30. (CM).

G. integra (Lec.) (3) Athens, Erie, Lucas. July 20–Oct. 1. (OSM, OSU, OU).

G. notulata (Fab.) (47) Adams, Athens, Gallia, Hamilton, Jackson, Lawrence, Meigs, Pike, Scioto, Vinton. June 23–Sept. 24. (CSNH, JHH).

G. notata (Fab.) (34) Ashtabula, Athens, Erie, Fairfield, Franklin, Hocking, Jackson, Medina, Portage, Vinton. Mar. 25–Sept. 24. (CM, JHH, OSM, OSU, OU, RML).

G. nymphaeae (L.) (231) Ashtabula, Hamilton, Jackson, Licking, Portage, Sandusky, Vinton. May 3–Sept. 21. (CM, CSNH, JHH, OSM, OSU).

G. tuberculata (Say) Hamilton. (CSNH).

G. decora (Say) (4) Hamilton, Portage. May 3–Aug. 16. (CM, CSNH).

G. luteola Mull. (39) Butler, Franklin, Hamilton, Montgomery. Aug. 22–Sept. 18. (CSNH, OSM, OSU).

Genus **Paratriarius** Schffr.

P. dorsata (Say) (36) Hamilton. June 24–Aug. 2. (CSNH, OSU).

Genus **Diabrotica** Chev.

D. duodecimpunctata (Fab.) (573) Adams, Ashtabula, Athens, Cuyahoga, Erie, Fairfield, Franklin, Gallia, Hamilton, Highland, Hocking, Holmes, Jackson, Lake, Lawrence, Licking, Lucas, Madison, Meigs, Monroe, Ottawa, Pike, Portage, Ross, Scioto, Stark, Vinton, Washington. Feb. 7–Nov. 12. (CM, CSNH, JHH, OSM, OSU, OU, RML).

D. longicornis (Say) (104) Athens, Coshocton, Cuyahoga, Franklin, Hamilton, Jackson, Meigs, Pickaway, Ross, Washington. July 12–Oct. 7. (CM, CSNH, JHH, OSU, OU).

D. atripennis (Say) (6) Adams, Madison. June 7–Aug. 26. (JHH, OSU).

D. vittata (Fab.) (292) Adams, Ashtabula, Athens, Auglaize, Cuyahoga, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Meigs, Monroe, Pickaway, Pike, Putnam, Ross, Summit, Vinton. April 7–Nov. 7. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Genus **Phyllobrotica** Redt.

P. decorata (Say) (2) Clark, Greene, Lucas. June 3–June 25. (OSM, OSU).

P. discoidea (Fab.) (1) Franklin, Hamilton. (CSNH, OSU).

P. limbata (Fab.) (25) Ashtabula, Athens, Hamilton, Hocking, Jackson, Lucas, Vinton. June 6–July 8. (CSNH, JHH, OSM, OSU, OU).

Other species of the Genus *Phyllobrotica* possible for Ohio: *P. vittata* Horn, *lengi* Blatch., *stenides* Schffr.

Genus **Luperodes** Mots.

L. meraca (Say) (21) Ashtabula, Athens, Hocking, Holmes, Jackson, Vinton. May 1–July 2. (JHH, OSM, OSU).

L. cyanellus Lec. (12) Athens, Gallia, Wayne. May 10–June 13. (CSNH, OSU, OU, RML).

Other species of the Genus *Luperodes* possible for Ohio: *L. thoracicus* (Melsh.).

Genus **Phyllecthrus** Lec.

P. gentilis Lec. (20) Athens, Gallia, Guernsey, Jackson, Lawrence, Meigs. May 30–June 24. (CSNH, JHH, OSU, OU, RML).

P. dorsalis (Oliv.) (1) Athens. June 9. (OU).

Genus **Galeruca** Geoffr.

G. pomonae Scop. (3) Athens, Hamilton, Hardin. May 20–Sept. 10. (CSNH, OSM, OU).

Genus **Cerotoma** Chev.

C. trifurcata (Forst.) (165) Adams, Athens, Champaign, Cuyahoga, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Marion, Medina, Meigs, Pike, Portage, Ross, Scioto, Vinton, Washington. May 1–Nov. 3. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Subfamily HALTICINAE

Genus **Blepharida** Rogers

B. rhois (Forst.) (640) Adams, Athens, Clermont, Coshocton, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Knox, Lawrence, Licking, Lucas, Medina, Meigs, Pike, Scioto, Vinton. May 8–Oct. 18. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Genus **Pachyonychus** Chev.

P. paradoxus Melsh. (10) Hamilton, Hocking, Jackson, Lawrence. May 22–June 9. (CSNH, JHH, OSU, OU).

Genus **Hypolampsis** Clark

H. pilosa (Ill.) (7) Hamilton, Jackson, Washington. July 2–July 12. (CSNH, JHH, OSU).

Genus **Oedionychis** Latr.

Oe. gibbitarsa (Say) (43) Athens, Clark, Erie, Fairfield, Franklin, Hamilton, Holmes, Jackson, Meigs. May 2–Oct. 10. (CSNH, JHH, OSM, OSU, OU, RML).

Oe. thoracica (Fab.) (16) Adams, Athens, Erie, Hamilton, Hocking, Vinton. April 25–Sept. 24. (CSNH, JHH, OSM, OSU, OU).

Oe. vians (Ill.) (24) Ashtabula, Athens, Franklin, Hamilton, Hocking, Jackson, Lawrence, Licking, Meigs. Feb. 10–Oct. 18. (CSNH, JHH, OSU, OU, RML).

Oe. fimbriata (Forst.) (12) Athens, Hocking, Jackson. Feb. 10–July 31. (JHH, OSM, OU, RML).

Oe. petaurista (Fab.) (2) Athens, Hamilton. June 17–Oct. 1. (CSNH, OU).

Oe. miniata (Fab.) (4) Hocking, Jackson, Lawrence. June 1–July 4. (JHH, OSM).

Oe. thyamoides Cr. (20) Athens, Franklin, Gallia, Hamilton, Vinton, Warren. May 2–Dec. 30. (CSNH, JHH, OSU, OU).

Oe. subvittata Horn (31) Ashtabula, Athens, Cuyahoga, Fulton, Hamilton, Jackson, Meigs, Scioto, Summit, Vinton, Wayne. April 8–Oct. 25. (CM, CSNH, JHH, OSU, OU).

Oe. sexmaculata (Ill.) (21) Athens, Clark, Gallia, Greene, Hamilton, Scioto, Vinton. April 28–Aug. 29. (CSNH, JHH, OSU, OU, RML).

Oe. quercata (Fab.) (52) Athens, Fairfield, Franklin, Gallia, Hocking, Holmes, Jackson, Pike, Scioto, Summit, Vinton. April 27–Aug. 27. (CM, JHH, OSM, OSU, OU).

Oe. scalaris Melsh. (1) Champaign. Sept. 6. (OSM).

Other species of the Genus *Oedionychis* possible for Ohio: *Oe. vians* var. *scripticollis* (Say), *concinna* (Fab.).

Genus **Disonycha** Chev.

D. **pennsylvanica** (Ill.) (16) Ashtabula, Auglaize, Franklin, Hamilton, Jackson, Ottawa, Portage, Washington. April 23–Aug. 16. (CM, CSNH, JHH, OSM, OSU, OU).
D. **procera** Csy. (11) Ashtabula, Jackson, Lucas, Washington. June 3–July 14. (JHH, OSM, OSU).
D. **uniguttata** (Say) (42) Erie, Fairfield, Geauga, Jackson, Licking, Morgan, Perry. April 18–Aug. 7. (JHH, OSM, OSU).
D. **alternata** (Ill.) (188) Ashtabula, Erie, Franklin, Hocking, Licking, Lucas, Ottawa, Preble, Ross, Washington. May 5–Sept. 21. (JHH, OSM, OSU, OU).
D. **caroliniana** (Fab.) Hamilton. (CSNH).
D. **fumata** Lec. (1) Hamilton. (CSNH).
D. **discoidea** (Fab.) (8) Athens, Hamilton, Jackson, Lawrence, Meigs. May 9–Aug. 15. (CSNH, JHH, OSU, OU, RML).
D. **discoidea** var. **abbreviata** Melsh. (7) Athens, Hamilton. May 31–June 23. (CSNH, JHH).
D. **admirabilis** Blatch. (52) Adams, Gallia, Hocking, Jackson, Lawrence, Licking, Pike, Scioto, Vinton, Washington. May 18–Sept. 25. (JHH, OSM).
D. **glabrata** (Fab.) (510) Adams, Athens, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Licking, Meigs, Pike, Ross, Scioto, Vinton, Washington. April 20–Oct. 23. (CSNH, JHH, OSM, OSU, OU, RML).
D. **collata** (Fab.) (1) Athens, Hamilton. June 26. (CSNH, JHH).
D. **semicarbonata** Lec. (1) Athens. (RML).
D. **xanthomelas** (Dalm.) (61) Ashtabula, Athens, Cuyahoga, Erie, Franklin, Hamilton, Hocking, Jackson, Licking, Meigs, Portage, Tuscarawas. April 23–Nov. 1. (CM, CSNH, JHH, OSM, OSU, OU, RML).
D. **triangularis** (Say) (18) Athens, Erie, Fairfield, Franklin, Hamilton, Lake, Lucas, Portage, Ross. April 1 to 9–Aug. 28. (CM, CSNH, JHH, OSM OSU).
D. **mellicollis** (Say) (9) Athens, Hamilton. May 15–Nov. 3. (CSNH, RML).
D. **pallipes** Cr. (4) Mercer, Portage, Summit. June 20–June 29. (CM, CSNH).

Genus **Sphaeroderma** Steph.

S. **opima** Lec. (11) Hamilton. May 19–July 18. (CSNH).

Genus **Altica** Geoffr.

A. **bimarginata** Say (30) Ashtabula, Erie, Hamilton, Hocking, Jackson, Lake, Licking, Lucas, Ottawa, Sandusky. May 8–Oct. 20. (CSNH, JHH, OSM, OSU, OU).
A. **chalybea** Ill. (34) Athens, Cuyahoga, Erie, Franklin, Hamilton, Hocking, Meigs, Richland, Ross. Mar. 29–Dec. 5. (CM, CSNH, JHH, OSM, OSU, OU, RML).
A. **ignita** Ill. (31) Athens, Fairfield, Franklin, Geauga, Hamilton, Hocking, Holmes, Jackson, Lawrence, Meigs, Vinton. April 23–Sept. 24. (CM, CSNH, JHH, OSM, OSU, OU).
A. **ulmi** Woods (141) Jackson. Nov. 11–Nov. 19. (JHH).
A. **carinata** Germ. (2) Hamilton, Scioto. Aug. 29. (CSNH, JHH).
A. **fuscoaenea** Melsh. (4) Hamilton. May 12. (CSNH).
A. **burgessi** Cr. Hamilton. (CSNH).
A. **rufa** Ill. (3) Franklin, Jackson. April 29–May 24. (JHH, OSU, OU).

Other species of the Genus *Altica* possible for Ohio: *A. rosae* Woods, *corni* Woods, *cuprascens* Blatch., *aenescens* Blatch., *vicaria* Horn, *torquata* Lec., *knabi* Blatch., *gloriosa* Blatch., *betulae* Schffr., *evicta* var. *shoemakeri* Schffr., *viatica* Blatch.

Genus **Lactica** Er.

L. **iris** (Oliv.) (2) Adams, Pike. Aug. 12–Aug. 24. (JHH).

Genus **Diphaulaca** Clark

D. **bicolorata** Horn (3) Hamilton. Mar. 24–Oct. 29. (CSNH).

Genus **Trichaltica** Har.

T. **scabricula** (Cr.) (7) Hamilton. May 14–June 4. (CSNH).

Genus **Chalcoides** Foudr.

C. **helxines** (L.) (1302) Adams, Ashtabula, Athens, Cuyahoga, Erie, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Lake, Lawrence, Meigs, Perry, Pike, Ross, Scioto, Vinton, Washington. April 24–Oct. 22. (CM, CSNH, JHH, OSM, OSU, OU).
C. **longula** (Horn) (28) Athens, Franklin, Hamilton, Jackson, Logan, Pike, Vinton. May 3–Oct. 15. (CSNH, JHH, OSM, OU).

Other species of the Genus *Chalcoides* possible for Ohio: *C. helxines* var. *violacea* (Melsh.).

Genus **Derocrepis** Weise

D. erythropus (Melsh.) (57) Adams, Athens, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Meigs, Ross. April 7–Oct. 7. (CSNH, JHH, OSM, OSU, OU, RML).
D. aesculi (Dury) (20) Franklin, Hamilton. April–May 24. (CSNH, OSU).

Genus **Crepidodera** Chev.

C. atriventris Melsh. (48) Athens, Cuyahoga, Franklin, Hamilton, Jackson, Lake, Pike, Scioto. Mar. 24–Oct. 21. (CM, CSNH, JHH, OSM, OU, RML).
C. nitens Horn (6) Athens, Hamilton. May 8–Aug. 1. (CSNH, JHH).

Genus **Hippuriphila** Foudr.

H. modeeri (L.) (8) Hamilton. May 20. (OSU).

Genus **Epitrix** Foudr.

E. fuscula Cr. (1503) Adams, Athens, Cuyahoga, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Lawrence, Meigs, Pike, Ross, Scioto, Vinton. May 2–Oct. 21. (CSNH, JHH, OSU, OU, RML).
E. humeralis Dury (15) Athens, Hamilton, Jackson, Meigs, Ross. May 16–Aug. 23. (CSNH, JHH, OU).
E. lobata Cr. (3) Athens, Hamilton. May 13–May 22. (CSNH, OU).
E. cucumeris Har. (644) Adams, Ashtabula, Athens, Cuyahoga, Franklin, Gallia, Jackson, Licking, Meigs, Pike, Ross, Vinton, Washington. May 6–Oct. 18. (CSNH, JHH, OSM, OSU, OU).
E. brevis Sz. (31) Athens, Cuyahoga, Jackson, Meigs, Ross, Washington. May 21–Aug. 26. (JHH, OU).
E. parvula (Fab.) (1471) Adams, Athens, Hamilton, Jackson, Lawrence, Meigs, Pike, Ross, Vinton. July 5–Sept. 2. (CSNH, JHH, OU).

Genus **Orthaltica** Cr.

O. copalina (Fab.) (18) Athens, Cuyahoga, Hamilton, Hocking, Jackson, Lawrence, Summit. May 26–July 30. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Other species of the Genus *Orthaltica* possible for Ohio: *O. melina* Horn.

Genus **Luperaltica** Cr.

L. fuscula (Lec.) (921) Adams, Athens, Gallia, Hocking, Jackson, Lawrence, Meigs, Pike, Ross, Scioto, Vinton. July 28–Sept. 26. (JHH, OU, RML).
L. senilis (Say) (2) Hamilton, Hocking, Scioto. July 20–Sept. 3. (CSNH, OSU, OU).

Genus **Mantura** Steph.

M. floridana Cr. (5) Cuyahoga, Franklin, Hamilton, Jackson. June 26–July 1. (CM, CSNH, JHH, OSM).

Genus **Chaetocnema** Steph.

C. protensa Lec. (4) Hamilton, Pike, Wayne. May 1–Aug. 18. (CSNH, JHH).
C. denticulata (Ill.) (9) Hamilton. May 14–Sept. 16. (CSNH).
C. cribrifrons Lec. (176) Adams, Athens, Jackson, Meigs, Scioto. July 4–Sept. 7. (JHH).
C. minuta Melsh. (132) Adams, Athens, Franklin, Gallia, Hamilton, Hardin, Hocking, Jackson, Lake, Meigs, Ross, Vinton. April 29–Sept. 27. (CSNH, JHH, OSU, OU, RML).
C. opulenta Horn (1) Hamilton. May 8. (CSNH).
C. parcepunctata Cr. Hamilton. (CSNH).
C. pulicaria Melsh. (40) Athens, Franklin, Hamilton. April 30–Oct. 19. (CSNH, OSU, OU).
C. confinis Cr. (73) Adams, Athens, Cuyahoga, Franklin, Gallia, Hamilton, Jackson, Meigs, Pike, Washington, Wayne. April 23–Oct. 28. (CSNH, JHH, OSM, OSU, OU, RML).
C. elongatula Cr. (3) Adams, Wayne. May 1–July 4. (CSNH).

Other species of the Genus *Chaetocnema* possible for Ohio: *C. irregularis* Lec., *subcylindrica* Lec., *pinguis* Lec., *protensa* var. *splendida* Gentn.

Genus **Systena** Clark

S. hudsonias (Forst.) (172) Ashtabula, Athens, Cuyahoga, Fairfield, Franklin, Gallia, Guernsey, Hamilton, Hocking, Jackson, Knox, Lucas, Meigs, Vinton, Wayne. May 22–Aug. 14. (CM, CSNH, JHH, OSM, OSU, OU, RML).
S. frontalis (Fab.) (33) Athens, Cuyahoga, Franklin, Jackson, Medina, Meigs, Portage, Washington. Jan. 16–Sept. 23. (CM, JHH, OSM, OU).
S. elongata (Fab.) (19) Athens, Cuyahoga, Gallia, Jackson, Medina, Meigs, Summit. July 27–Nov. 18. (CM, JHH, OSU).

S. taeniata (Say) (441) Adams, Ashtabula, Athens, Cuyahoga, Erie, Gallia, Hamilton, Jackson, Lake, Lawrence, Meigs, Pike, Ross, Scioto, Shelby, Vinton, Washington. May 30–Sept. 7. (CSNH, JHH, OSM, OSU, OU, RML).

S. blanda Melsh. Putnam, Wood. Blake (1935) examined this species from the Ohio counties given.

S. marginalis (Ill.) (49) Adams, Athens, Cuyahoga, Franklin, Gallia, Jackson, Lawrence, Meigs, Pike, Ross. Aug. 1–Sept. 17. (CSNH, JHH, OSM, OU).

Other species of the Genus *Systena* possible for Ohio: *S. plicata* Blatch.

Genus **Longitarsus** Latr.

L. turbatus Horn (15) Hamilton. April 1–Nov. 6. (CSNH).

L. alternatus (Zieg.) (19) Hamilton. May 12–June 21. (CSNH).

L. testaceus Melsh. (25) Athens, Cuyahoga, Hamilton, Jackson, Lake, Lucas, Meigs, Pike. Vinton. May 14–Oct. 15. (CSNH, JHH, OSU, OU).

L. melanurus Melsh. (16) Athens, Hamilton. April 23–Oct. 22. (CSNH, OU).

L. insolens Horn (1) Hamilton. June 12. (CSNH).

L. misellus Blatch. (24) Hamilton. April 5–Oct. 26. (CSNH).

Other species of the Genus *Longitarsus* possible for Ohio: *L. subrufus* Lec., *erro* Horn, *arenaceus* Blatch., *suspectus* Blatch., *saltatus* Blatch., *acutipennis* Blatch., *waterhousi* Kutschera.

Genus **Glyptina** Lec.

G. cyanipennis Cr. (2) Hamilton. July 8. (CSNH).

G. brunnea Horn (22) Athens, Franklin, Hamilton, Hocking, Ross. Jan. 9–April 19. (CSNH, JHH, OSM, OSU, OU).

G. spuria Lec. (16) Athens, Cuyahoga, Hamilton. Mar. 25–Nov. 6. (CM, CSNH, OU).

Other species of the Genus *Glyptina* possible for Ohio: *G. bicolor* Horn, *ferruginea* Blatch., *leptosoma* Blatch., *abbreviata* Gentn.

Genus **Phyllotreta** Foudr.

P. armoraciae (Koch) (114) Ashtabula, Athens, Cuyahoga, Franklin, Jackson. April 9–Oct. 25. (CM, JHH, OSM, OSU, OU).

P. robusta Lec. (1) Hamilton. June. (CSNH).

P. zimmermanni (Cr.) (61) Athens, Franklin, Hamilton, Jackson, Knox, Lawrence, Meigs, Ottawa, Vinton. April 5–Aug. 19. (CSNH, JHH, OSM, OSU, OU, RML).

P. vittata (Fab.) (318) Adams, Athens, Cuyahoga, Franklin, Gallia, Hamilton, Jackson, Lawrence, Meigs, Scioto. Jan. 27–Oct. 25. (CM, CSNH, JHH, OSU, OU).

P. bipustulata (Fab.) (60) Adams, Athens, Cuyahoga, Franklin, Gallia, Hamilton, Jackson, Meigs, Summit. Apr. 22–Dec. 25. (CM, CSNH, JHH, OSU, OU).

P. ulkei Horn (1) Franklin. April 5. (OSM).

P. lindahli Dury (5) Hamilton. May 20–May 30. (CSNH).

P. picta (Say) (45) Adams, Athens, Gallia, Hamilton, Jackson, Lawrence, Lucas, Ottawa, Vinton. May–Aug. 16. (CSNH, JHH, OSU, OU, RML).

Other species of the Genus *Phyllotreta* possible for Ohio: *P. liebecki* Schffr., *ramosa* (Cr.), *conjuncta* Gentn , *aeneicollis* (Cr.), *lewisii* (Cr.).

Genus **Tanygaster** Blatch.

Species of the Genus *Tanygaster* possible for Ohio: *T. ovalis* Blatch.

Genus **Aphthona** Chev.

A. insolita (Melsh.) (3) Athens, Hamilton. May 22–May 24. (CSNH, OU).

Genus **Dibolia** Latr.

D. borealis Chev. (382) Athens, Franklin, Hamilton, Jackson, Pike. Jan. 5–Dec. 25. (CSNH, JHH, OSU, OU, RML).

Other species of the Genus *Dibolia* possible for Ohio: *D. libonoti* Horn.

Genus **Psylliodes** Latr.

P. punctulata Melsh. (4) Athens, Franklin. June 24–June 26. (JHH, OSU).

P. convexior Lec. (17) Cuyahoga, Franklin, Hamilton, Jackson. April 24–Aug. 14. (CSNH, JHH, OSM, OSU).

Subfamily HISPINAE

Genus **Stenispa** Baly

S. metallica (Fab.) (25) Fairfield, Franklin, Gallia, Hamilton, Jackson, Lawrence, Licking, Pickaway. April 29–Sept. 8. (CSNH, JHH, OSU).

Other species of the Genus *Stenispa* possible for Ohio: *S. collaris* Baly.

Genus **Anoplitis** Chap.

A. inaequalis (Web.) (228) Adams, Ashtabula, Athens, Carroll, Champaign, Cuyahoga, Fairfield, Gallia, Hamilton, Hocking, Jackson, Lawrence, Meigs, Ottawa, Pike, Ross, Vinton, Washington. May 5–Dec. 29. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Genus **Chalepus** Thunb.

C. bicolor (Oliv.) (23) Athens, Clermont, Gallia, Hocking, Jackson, Lawrence, Meigs, Vinton. May 9–Sept. 3. (CSNH, JHH, OSM, OSU, OU).

C. scapularis (Oliv.) (6) Adams, Hocking, Jackson. July 2–Aug. 25. (CSNH, JHH, OSU).

C. dorsalis Thunb. (73) Adams, Ashtabula, Athens, Champaign, Cuyahoga, Gallia, Geauga, Hamilton, Jefferson, Lawrence. May 10–Oct. 20. (CM, CSNH, JHH, OSM, OSU, OU).

C. horni (Smith) (4) Adams, Athens, Lawrence. May 13–Sept. 1. (JHH, OSU, OU).

Genus **Baliosus** Weise

B. ruber (Web.) (45) Athens, Champaign, Cuyahoga, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Ottawa, Ross. April 28–Oct. 8. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Genus **Brachycoryna** Baly

Species of the Genus *Brachycoryna* possible for Ohio: *B. ?melsherimeri* (Cr.).

Genus **Octotoma** Suffr.

O. plicatula (Fab.) (21) Hamilton, Lawrence, Meigs. May 11–June 13. (CSNH, OSM, OSU).

Genus **Uroplata** Baly

U. porcata (Melsh.) (4) Athens, Hamilton. May 22–Aug. (CSNH, RML).

Genus **Microrhopala** Baly

M. vittata (Fab.) (48) Adams, Ashtabula, Champaign, Clermont, Cuyahoga, Erie, Fairfield, Hamilton, Jackson, Medina, Portage. May 15–Oct. 7. (CM, CSNH, JHH, OSU, OU).

Other species of the Genus *Microrhopala* possible for Ohio: *M. xerene* (Newn.), *excavata* (Oliv.), *cyanea* (Say).

Subfamily CASSIDINAE

Genus **Chelymorpha** Boh.

C. cassidea (Fab.) (88) Adams, Ashtabula, Athens, Clark, Clermont, Cuyahoga, Erie, Fairfield, Franklin, Fulton, Greene, Hamilton, Huron, Jackson, Lawrence, Licking, Meigs, Ottawa, Pike, Ross, Sandusky, Summit, Vinton, Washington, Wayne. Feb. 17–Sept. 12. (CM, CSNH, JHH, OSM, OSU, OU, RML).

Genus **Physonota** Boh.

Species of the Genus *Physonota* possible for Ohio: *P. unipunctata* (Say).

Genus **Cassida** L.

Species of the Genus *Cassida* possible for Ohio: *C. flaveola* Thunb.

Genus **Jonthonota** Spaeth

J. nigripes (Oliv.) (6) Clark, Cuyahoga, Greene, Hamilton, Jackson, Logan. June 8–Sept. 14. (CM, CSNH, JHH, OSU).

Genus **Gratiana** Spaeth

G. pallidula (Boh.) (127) Adams, Athens, Gallia, Hocking, Jackson, Lawrence, Meigs, Pike, Scioto, Washington. June 16–Aug. 29. (JHH, OSU, OU).

Genus **Chirida** Chap.

C. guttata (Oliv.) (175) Adams, Athens, Cuyahoga, Erie, Fairfield, Franklin, Gallia, Hamilton, Hocking, Jackson, Lake, Lawrence, Meigs, Ottawa, Pike, Ross, Scioto, Seneca, Summit, Vinton, Washington. April 28–Sept. 26. (CM, CSNH, JHH, OSU, OU, RML).

C. guttata var. **pennsylvanica** Sp. (46) Athens, Cuyahoga, Fairfield, Franklin, Hamilton, Highland, Jackson, Lawrence, Meigs, Mercer, Pike, Vinton. May 5–Oct. 11. (CM, CSNH, JHH, OSM, RML).

Genus **Deloyala** Chev.

D. clavata (Fab.) (24) Ashtabula, Athens, Cuyahoga, Erie, Hamilton, Hocking, Jackson, Meigs, Ottawa, Wood. May 24–Aug. 20. (CSNH, JHH, OSM, OSU, OU).

Genus Metriona Weise

M. bivittata (Say) (176) Adams, Athens, Clark, Fairfield, Greene, Hamilton, Highland, Hocking, Jackson, Lake, Lawrence, Meigs, Pike, Ross, Seneca, Vinton, Washington. April 15–Oct. 23. (CSNH, JHH, OSM, OSU, OU, RML).

M. bicolor (Fab.) (311) Adams, Ashtabula, Athens, Champaign, Clark, Cuyahoga, Erie, Fairfield, Franklin, Gallia, Greene, Hamilton, Highland, Hocking, Holmes, Jackson, Lake, Lawrence, Lucas, Meigs, Ottawa, Pike, Ross, Scioto, Seneca, Vinton, Washington. April 28–Oct. 13. (CM, CSNH, JHH, OSM, OSU, OU, RML).

M. purpurata (Boh.) (4) Athens, Hamilton, Vinton. May 17–Aug. 17. (CSNH, JHH).

LITERATURE CITED

Barber, H. S. *A Review of North American Tortoise Beetles (Chrysomelidae, Cassidinae).* Proc. Ent. Soc. Washington, Vol. XVIII, No. 2, 1916. pp. 113–127.

Blackwelder, Richard E. *Fourth Supplement 1933 to 1938 (inclusive) to (Leng) Catalogue of the Coleoptera of America North of Mexico.* Mount Vernon: John D. Sherman, Jr., 1939.

Blake, Doris Holmes. *A Revision of the Beetles of the Genus Oedionychis Occurring in America North of Mexico.* Washington: Government Printing Office, 1927. Proc. U. S. Nat. Mus., Vol. 70, Art. 23. pp. 1–44, pls. 1, 2.

Revision of the Species of Beetles of the Genus Trirhabda North of Mexico. Washington: Government Printing Office, 1931. Proc. U. S. Nat. Mus., Vol. 79, Art 2. pp. 1–36, pls. 1, 2.

Revision of the Beetles of the Genus Disonycha Occurring in America North of Mexico. Washington: Government Printing Office, 1933. Proc. U. S. Nat. Mus., Vol. 82, Art. 28. pp. 1–66, pls. 1–8.

Notes on Systena. Bulletin Brooklyn Ent. Society, Vol. XXX, No. 3, June, 1935. pp. 89–108, pl. 1.

Blatchley, W. S. *Coleoptera or Beetles Known to Occur in Indiana.* Indianapolis: Indiana Dept. of Geology and Nat. Resources, Bul. No. 1, 1910. 1385 pp.

Chittenden, F. H. *The Species of Phyllotreta North of Mexico.* Brooklyn Ent. Soc., VIII (New Series), No. 1, 1927. pp. 1–60, pls. 1, 2.

Dury, Charles. *A Revised List of the Coleoptera Observed Near Cincinnati, Ohio.* Jour. Cincinnati Soc. Nat. Hist., XX, 1902. pp. 107–196.

Additions to the List of Cincinnati Coleoptera. Jour. Cincinnati Soc. Nat. Hist., XX, No. 7, 1906. pp. 257–260.

Ecological Notes on Some Coleoptera of the Cincinnati Region, Including Seven New Species. Jour. Cincinnati Soc. Nat. Hist., XX, No. 7, 1906. pp. 251–256.

Fall, H. C. *A Revision of the North American Species of Pachybrachys.* Trans. Am. Ent. Soc., XLI (September, 1915). pp. 291–486.

Houser, J. S. *Destructive Insects Affecting Ohio Shade and Forest Trees.* Ohio Agr. Exp. Sta., Bul. 332, 1918. 487 pp.

Hughes, John H. *Chrysomelidae or Leaf Beetles of Southeastern Ohio.* Unpublished Master's Thesis, Ohio University, Athens, Ohio, 1939. 147 pp.

Krauss, N. L. H. *A Study of the Genus Glyptoscelis LeConte In America North of Mexico (Coleoptera, Chrysomelidae).* Berkeley, Calif.: Univ. of Calif. Press, 1937. Univ. of Calif. Publ. in Ent., Vol. 7, No. 2. pp. 21–32, 9 figs.

Leng, Charles W. *Catalogue of the Coleoptera of America North of Mexico.* Mount Vernon: John D. Sherman, Jr., 1920. 470 pp.

Leng, Charles W., and Andrew J. Mutchler. *Supplement 1919 to 1924 (inclusive) to Catalogue of the Coleoptera of America North of Mexico.* Mount Vernon: John D. Sherman, Jr., 1927.

Second and Third Supplements 1925 to 1932 (inclusive) to Catalogue of the Coleoptera of America North of Mexico. Mount Vernon: John D. Sherman, Jr., 1933.

Leonard, Mortimer D., et al. *A List of the Insects of New York.* Ithaca: Cornell Univ. Agr. Exp. Sta., Mem. 101, 1926. 1121 pp.

McCauley, R. H., Jr. *A Revision of the Genus Microrhopala in N. A., North of Mexico.* Bul. Brooklyn Ent. Soc., XXXIII, No. 4, 1938. pp. 145–169, pl. 1.

Mutchler, Andrew J., and Harry B. Weiss. *Leaf-Beetles of the Genus Galerucella Known to Inhabit New Jersey.* State of N. J. Dept. Agr., Cir. 98, 1926. 15 pp.

Schaeffer, Charles. *Revision of the New World Species of the Tribe Donaciini of the Coleopterous Family Chrysomelidae.* Brooklyn, N. Y.: Brooklyn Mus. Sci. Bul., Vol. 3, No. 3 (July, 1925). pp. 45–165, pl. 1.

Van Dyke, Edwin C. *A Review of the Genus Chrysolina Motschulsky in N. A. (Coleoptera, Chrysomelidae).* Bull. Brooklyn Ent. Soc., XXXIII, No. 2, 1938. pp. 45–58.

Woods, William Colcord. *The Biology of Maine Species of Altica.* Maine Agr. Exp. Sta., Bull. 273, 1918. pp. 149–204, pls.

A MUTATION IN CORN PERICARP

DAVID C. RIFE,[1]
The Ohio State University,
Columbus, Ohio

The ear of corn shown in Fig. 1 was observed in a farmer's corn field. The color variation is in the pericarp, the dark area being red, and the light portion yellow, the latter being due to yellow endosperm showing through colorless pericarp. The red pericarp was at first assumed to be the result of a mutation from colorless to dominant red pericarp. It was assumed that half of the red kernels should carry the gene for red pericarp in their embryos, if ovulary as well as pericarp tissue was descended from the mutant cell. In order to test this hypothesis, a few red and yellow kernals were planted separately.

Fig. 1. Ear of corn in which a mutation occurred in the pericarp.

As predicted, half of the plants grown from red kernels produced solid red ears and the other half produced solid yellow ears (five plants of each). Surprising results were obtained from the yellow kernels. Instead of producing only plants with yellow ears, five produced plants with yellow ears and four produced plants with variegated ears. These variegated ears had red and colorless stripes in the pericarp of the individual kernels over the entire ears.

A series of multiple alleles determines pericarp color (Emerson, 1917; Hayes, 1917; Eyster, 1924). The gene P^{vv} results in variegated. Another gene, P^{wr} results in colorless, which is dominant to variegated. A third member of the series, P^{rr} results in solid red pericarp, which is dominant to both colorless and variegated.

---

[1] Genetics Laboratory, Department of Zoology and Entomology.

The plant which gave rise to the ear shown in Fig. 1 must have been heterozygous for colorless and variegated (P^{wr} P^{vv}). A mutation from variegated to red ($P^{vv} \rightarrow P^{rr}$) occurred in the developing ear. Female gametes within the red kernels were of two genotypes, half P^{rr} and half P^{wr}. They were fertilized by pollen from tissue of genotype P^{wr} P^{vv}. Half of the offspring of the red kernels should produce solid red ears and half should produce solid yellow ears. (P^{rr} P^{wr} x P^{wr} P^{vv}). The yellow kernels should produce offspring in the ratio of three with yellow ears to one with variegated ears (P^{wr} P^{vv} x P^{wr} P^{vv}). While the number of plants grown was too small to differentiate between 1 : 1 and 3 : 1 ratios, a mutation of the recessive gene for variegated to the dominant gene for solid red pericarp satisfactorily explains the peculiar breeding behavior.

LITERATURE CITED

Emerson, R. A. 1917. Genetical studies of variegated pericarp in maize. Genetics, 2: 1-35.
Hayes, H. K. 1917. Inheritance of a mosaic pericarp in maize. Genetics, 2: 260-284.
Eyster, W. H. 1924. A genetic analysis of variegation. Genetics, 9: 372–404.

Manual of Medical Parasitology

The contents of this book consist of the following parts: Preface, Table of Contents, Trematodes, Cestodes, Nematodes, Intestinal Protozoa, Hemoflagellates, Malarial Parasites of Man, Mosquitoes Which Transmit Disease, Flies which Transmit or Cause Disease, Other Bloodsucking Insects Which Transmit Disease, Ticks and Mites, Laboratory Diagnosis of Parasitic Infections, Reference Books, and Index. There are twelve pages of excellent figures and the one illustrating Plasmodium is in color.

This manual is designed to assist the medical student in identifying and studying in the laboratory those parasites which are often found in or on man. Numerous comments will assist the student in understanding the epidemiology and especially the diagnosis of parasitic infections. The manual is therefore valuable not only to students in college but to all wishing a rapid first survey or a thorough review of a subject which World War II has forced Americans to study.

—*C. E. Venard.*

A Manual of Medical Parasitology, by Clay G. Huff. x+88 pages. University of Chicago Press, 5750 Ellis Avenue, Chicago 37. 1943. Price, $1.50.

AN ANALYSIS OF FISHING EFFORT AT INDIAN LAKE

LOWELL E. BINKLEY,[1]
Section of Fish Management and Propagation,
Ohio Division of Conservation and Natural Resources,
Columbus, Ohio

Although the study of natural sciences dates back many centuries, the science of the management of fish populations is very young. Students of fish management have always been confronted with the major problem of estimating, within reasonable limits, the value of their efforts. Unlike the farmer, who may determine exactly the production of his lands, the biologist is still unable to determine the production of fish in any large body of water under natural conditions.

Numerous plans for the practical management of fish populations have been offered. As yet, no satisfactory method has been developed for testing the relative values of these plans. Thompson and Bennett (1938) in Illinois and Swingle and Smith (1942) in Alabama and others have supplied excellent data on the production of fish in ponds and lakes under more or less controlled conditions.

In newly constructed lakes it would be possible to keep a careful check on the number and weight of fish introduced. A check of all of the fish taken out of the lake over a period of years would produce some pertinent information. It is, however, impossible to contact all fishermen around most of our lakes.

The use of special chemicals, electrical devices and nets promises to supply valuable data when we arrive at the point where it is possible to standardize this information. For the present, we must rely upon random samples obtained by a creel census. This census may be conducted by the personal contact method or on a voluntary basis. The personal contact method has proven to be the more satisfactory of the two methods. At Indian Lake we combined the two methods by placing twenty creel census boxes at popular fishing landings. The individuals operating these landings assisted the fishermen in making out their reports of catch.

We should plan, however, to operate the creel census at Indian Lake over a period of years. Sufficient data may be acquired during this period to enable us to arrive at some definite conclusions as to the productive capacity of Indian Lake.

THE TOTAL CATCH

As previously suggested, the ideal method for the operation of a creel census is to check the creels of all fishermen as they leave the lake. With the means we had available, it was impossible to check the fifty miles of shore line and the approximately 7200 acres of water (Roach, 1935). The information obtained at this lake over a period of six months represents only a sample of the adult fish populations and provides no basis for computing the total production of fish. The total catch of 13,938 legal-sized fish by 1,104 fishermen results in an average daily catch of 12 legal-sized fish per fisherman. Only 611 undersized fish were reported as being caught and returned to the water. Approximately four fish in every hundred caught were undersized.

Throughout the period of the survey fifteen species of fish were caught. During April fourteen species of fish were caught and this number became less until, in August, only seven species were caught. Among the fifteen species of fish caught were six representatives of the sunfishes (*Centrarchidae*) and three of the catfishes (*Ameiuridae*). This report should probably show five species of catfish but, due to the inability of the layman to separate the bullheads, it was necessary to consider them as one species. Nearly eight sunfish were caught to two of all other species of fish. And of this two, approximately one and a half were catfish. Table I lists the number of each species taken each month as well as the total number taken throughout the period of the survey.

---

[1] The writer is indebted to Dr. T. H. Langlois, Director of The Theodore Franz Stone Laboratory, and Dr. W. C. Beaver, Department of Biology, Wittenberg College, for their assistance and advice.

In considering only the sunfish and catfish it is interesting to observe that nine out of every ten of these two families of fishes caught in April were sunfish. This ratio became systematically reduced until, in August, the ratio of six sunfish to four catfish resulted. In other words, the spring season is the best period to fish for sunfish and the late summer is the best period to obtain catfish. Table II indicates the percentage of the total catch per month for each species as well as the percentage of the total catch for each species.

TABLE I

TOTAL CATCH OF FISH

(Indian Lake Creel Census)

Species	April	May	June	July	Aug.	Sept	Totals
Crappie	4,460	2,083	222	161	274	67	7,467
Bluegill	810	564	308	457	194	79	2,412
Channel Cat	529	423	190	360	265	100	1,867
L. M. Bass	606	17	65	56	55	0	799
Perch	63	58	50	302	130	102	705
Bullheads	231	25	34	44	86	10	403
Sunfish	29	26	16	36	10	23	140
Carp	7	3	10	9	5	0	34
Rock Bass	2	22	1	0	0	0	25
R. Trout	10	8	0	0	0	0	18
S. M. Bass	9	2	3	0	3	0	17
White Bass	9	3	0	0	0	0	12
Wall-eye Pike	4	0	0	2	0	0	6
Blue Cat	0	0	1	1	1	1	4
Goldfish	2	0	0	0	0	0	2
Totals	6,971	3,234	900	1,428	1,023	382	13,938

Wickliff (1935) conducted a state-wide creel census from seven Ohio lakes. From the data supplied in this report an average daily catch of eleven legal-sized fish per fisherman was obtained. This survey, covering the same period of the year as the Indian Lake survey, further reveals that an average of 2.6 legal-sized fish were caught per hour. At Indian Lake an average of 12 legal-sized fish were caught at the rate of slightly more than two legal-sized fish per hour. This information is summarized for each month of the survey in Table III.

THE WEATHER

Weather conditions usually provide an excellent topic for discussion among fishermen. Some fish according to wind directions, others by periods of the moon, and, more recently, according to barometer readings. Daily observations are made at the conservation office at Russell's Point as to the air temperature, wind direction, relative strength of the wind, and precipitation. Daily water temperatures, although not available, would be highly desirable.

April and May, the two coldest months of the survey, provided the best crappie fishing. During the remaining four months of the survey the crappie catches were considerably reduced. In fact, April and May are the best months for most types of fishing. During the month of April and the early part of May the average daily catch of all species of fish follows, very closely, the daily air temperatures.

TABLE II

PERCENTAGE OF CATCH PER MONTH

(Indian Lake Creel Census)

Species	April	May	June	July	Aug.	Sept.
Crappie	66.84	64.40	24.66	11.27	26.78	17.03
Bluegill	11.76	14.34	34.22	32.00	18.86	20.86
Channel Cat	7.59	13.07	21.11	25.21	25.90	26.17
L. M. Bass	8.69	0.52	7.22	3.82	5.37	0.00
Perch	0.90	1.79	5.55	21.14	12.70	26.70
Bullheads	3.45	0.77	3.77	3.08	8.40	2.61
Sunfish	0.41	0.80	1.77	2.52	0.97	6.02
Carp	0.10	0.09	1.11	0.63	0.48	0.00
Rock Bass	0.02	0.68	0.11	0.00	0.00	0.00
R. Trout	0.14	0.24	0.00	0.00	0.00	0.00
S. M. Bass	0.12	0.06	0.33	0.00	0.29	0.00
White Bass	0.12	0.09	0.00	0.00	0.00	0.00
Wall-eye Pike	0.04	0.00	0.00	0.14	0.00	0.00
Blue Cat	0.00	0.00	0.11	0.07	0.09	0.26
Goldfish	0.02	0.00	0.00	0.00	0.00	0.00

TABLE III

CATCH PER HOUR FOR ALL SPECIES

(Indian Lake Creel Census)

Month	Number of Fishermen Reporting	Legal-sized Fish Taken	Average Number of Fish Per Fisherman	Average Number of Legal-sized Fish Per Hour
April	574	6,971	12.14	2.65
May	206	3,234	15.70	2.29
June	80	900	11.20	3.07
July	128	1,428	11.10	2.26
August	83	1,023	12.20	1.50
September	33	382	11.50	1.07
Totals	1,104	13,938	12.60	2.14

In other words, as the days become warmer the fishermen devote more and more time to fishing and, as a result, catch more fish. Once the waters of a lake reach their normal summer temperatures daily changes in air temperature have very little immediate influence upon the temperature of the water. During this period no correlation between daily catches of fish and daily air temperature is evident.

THE CRAPPIE FISHING

The best crappie fishing is provided during the months of April and May. From Table II it is quite evident that two out of every three legal-sized fish caught during April and May are crappies. The remaining four months of the survey show decided decline in crappie catches.

Although most of the crappie fishing is done from boats, there appears to be no great advantage over fishing from the shore. The average catch of legal-sized crappies among the boat fishermen was fourteen compared with twelve for the shore fishermen. Live minnows and artificial flies proved to be the most effective baits. All other types of baits used resulted in a fifty per cent reduction in catches.

THE BLUEGILL FISHING

Based on the information presented in Table II, June and July appear to be the best months for bluegill (*Lepomis macrochirus*) fishing. This is probably true for the majority of fishermen. From this table it would also appear that April and May provided the poorest bluegill fishing. This resulted, no doubt, from the fact that most of the people fishing the lake were using live minnows for bait and this type of bait was not very acceptable to the bluegills.

Those fishermen who specialized in bluegill fishing during April and May were very successful. Their average daily catch of bluegills was nearly seventy-five per cent of the daily bag limit of twenty bluegills. Using artificial flies, these fishermen consistently caught the most bluegills. Worms, although very popular as a bluegill bait, did not provide good catches except during the early part of the season. A boat is also essential to good bluegill fishing as is evidenced by the fact that the boat fishermen consistently caught twice as many bluegills as the shore fishermen.

CHANNEL CATFISHING

Table II reveals that July, August and September are the best months for the majority of the channel cat fishermen. This table would also seem to indicate that April and May are not good months to fish for channel catfish (*Ictalurus lacustris*). However, the same conditions which held down the bluegill catches during this period also appear to have reduced the catches of channel catfish. Very few channel catfish were caught with minnows.

More channel catfish were caught per day with worms during April than at any other time during the six-month survey. Soft "craws" and shrimp also proved to be very effective baits. A boat is essential for good catches of channel catfish as is evidenced by the fact that the average daily catch of the boat fishermen was three times that of the shore fishermen.

LARGEMOUTH BASS FISHING

For many years Indian Lake has been a favorite location for largemouth bass (*Huro salmoides*) fishing. The information supplied by these fishermen indicates that the month of April provides the best largemouth bass fishing. During this period the bass fishermen took home fifty per cent of the daily bag limit of six bass per trip. In fact, fifty per cent less time was required to catch a legal-sized bass in April than at any other time during the survey. The last two weeks of June also provided excellent bass fishing.

The boat fishermen consistently caught more bass than the shore fishermen and this indicates the importance of a boat for more successful bass fishing. During the early part of the season artificial baits were very effective. By the middle of July, soft "craws" appeared to be the best bait.

THE PERCH FISHING

Although the perch (*Perca flavescens*) ranked among the five most important game fishes during the period of the survey, this species appears to be finding it increasingly more difficult to maintain itself. September provided the best perch fishing. The perch caught during the summer months are small while the larger perch are caught during the winter months.

In view of the fact that the boat and shore fishermen caught, on the average, the same number of perch, there appears to be no advantage in fishing for perch from a boat During April and May most of the perch were caught with live minnows while worms provided the best bait during the remainder of the season.

THE FISHING PRESSURE

During the early part of the season most of the fishermen come from communities near and around the lake. This is, no doubt, due to the fact that poor weather conditions discourage fishermen from driving long distances for a few hours of fishing. Lima supplies a higher percentage of the fishermen during this period than any other city. With the closing of the bass season throughout May and the first two weeks of June, most of the fishermen come from nearby communities.

It is interesting also to observe that by the first of July local interest in angling reaches a very low level. This condition continues throughout the remainder of the season. Among the cities supplying most of the fishermen during this period were Columbus, Dayton and Springfield. The Miami Valley supplies about one-half of the fishermen visiting the lake while the remainder come from all over Ohio as well as neighboring states.

THE CREEL CENSUS AND LAKE MANAGEMENT

The first step in planning an improvement project for a selected area is to complete an inventory. The creel census supplies information as to the size and relative abundance of the various species of fish inhabiting the lake. The program may then be directed toward improving habitat for the desired species of fish. Included in the inventory should be an evaluation of spawning facilities, cover and food supply.

From the study of lakes it becomes quite evident that each lake presents a new series of fish management problems. The size of the lake is also important due to the fact that the larger lakes are, as a general rule, more difficult to manage. Fortunately, however, the numerous islands of Indian Lake more or less divide the lake into a number of smaller lakes. Each of these smaller lakes may be treated as individual cases.

The major problem at Indian Lake is to reclaim the once productive bays of the east and west ends of the lake. Natural forces operating on a lake constantly move in the direction of destroying the lake. This movement can best be summarized as an ecological succession. As new soils are formed by the decomposition of aquatic vegetation some areas become isolated ponds. In time these ponds become swamps and, eventually, dry land.

Our first problem is to gain control of the aquatic vegetation dominating these bays. A certain amount of aquatic vegetation is required by fish but when these bays become "solid" with vegetation they no longer provide suitable habitat for the desirable species of fish. The submerged aquatic vegetation of Dunn's Pond, Cranberry, Long Island, Turkeyfoot and Sassafras areas require special attention. Waterweed (*Elodea*) and coontail (*Ceratophyllum*) constitute the vegetation problem of the above mentioned areas. Both of these plants still dominate bays after several years of cutting with machines. Small pieces of the plants drift away during the cutting operation and supply many new areas with this type of vegetation.

The emergent aquatic vegetation of North Fork, Bear Wallow and Lucy's Pond present another type of vegetation problem. Cattails (*Typha*) constitute a major problem in these areas. This type of vegetation may be controlled by proper cutting. In Bear Wallow and Lucy's Pond channels and ponds should be cut out by dredge operation. This action will provide for the maximum circulation of water.

In areas where suitable gravel for spawning beds is not provided by dredging, additional gravel may be supplied. This can best be done by moving the gravel out on the ice. When the ice melts the gravel falls to the bottom to provide excellent spawning beds for game fish. Logs and stumps should be left in these areas to provide the necessary amount of cover. Some areas may require additional cover and logs and stumps may be supplied.

The improved areas should be set aside as sanctuaries throughout the spawning season. Such areas should be opened to fishing throughout the remainder of the year. The control of motor boats in fishing areas, proper bag limits, legal lengths and closed seasons complete the program.

CONCLUSIONS

1. The spring provides the best season for the greatest number and type of fishermen at Indian Lake.

2. The crappie is the dominant fish of Indian Lake and will continue as the dominant game fish as long as the conditions within the lake remain as they are at the present time.

3. The average daily catch of twelve legal-sized fish per fisherman compares favorably with other Ohio lakes.

4. Boat fishermen usually catch more fish than shore fishermen. Boat fishermen caught twice as many bluegills as the shore fishermen. Three times as many channel catfish were caught per unit of time from a boat as compared with the shore fishermen. Very few largemouth bass are caught from the shore.

5. Those fishermen who specialize in certain types of fishing consistently catch more fish than the "general" fishermen.

6. The fishing pressure is supplied locally during the early part of the season while the more distant communities supply most of the fishing pressure during the latter part of the season.

REFERENCES CITED

Roach, Lee S. Some physical, chemical and biological studies of impounded waters of Ohio. Transactions of the American Fishery Society, 63: 267–70. 1933.

Swingle, H. S. and E. V. Smith. Management of farm fish ponds. Agricultural Experiment Station, Alabama Polytechnic Institute, Auburn, Alabama. Bulletin 254, April, 1942.

Thompson, David H. and G. W. Bennett. The effect of crowding on the growth of game fishes; as shown by studies of Horseshoe Lake, 1931–38. Illinois Conservation Department, Urbana, Illinois. Summer 1939.

Wickliff, E. L. Summary of a preliminary creel census for seven Ohio lakes during the spring, summer and fall of 1935. Bulletin 95, Ohio Division of Conservation, Columbus, Ohio.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIV JULY, 1944 No. 4

A KEY TO THE GENERA OF ANISOPTEROUS DRAGONFLY NYMPHS OF THE UNITED STATES AND CANADA (ODONATA, SUBORDER ANISOPTERA)

MIKE WRIGHT[1] AND ALVAH PETERSON,
Department of Zoology and Entomology,
The Ohio State University

Since the publication of "A Handbook of the Dragonflies of North America" by Needham and Heywood in 1929, much additional information concerning the immature stages has been accumulated and nymphs of a number of previously unknown genera and species have been described. Several students of the Odonata (Byers, 1936, and Needham and Fisher, 1936), have published revised keys to certain families or subfamilies, but no comprehensive key to the order as a whole has as yet appeared. This paper covers all of the genera of Anisopterous dragonflies known from North America north of Mexico. Keys are presented for the identification of the genera and a list of available literature for specific identification is appended. A glossary of all terms used and illustrations of the majority of the structures of nymphs are included. It is suggested that the beginning student study closely figures E and F of Plate 1, figures L and N of Plate 3, figure G of Plate 4, and figure J of Plate 5 before attempting to use the keys. In these figures are illustrated most of the structures used in the generic identification of Odonata nymphs.

The senior author is responsible for the greater portion of the taxonomic part of this paper, while the junior author has contributed the many illustrations and has helped on the other portions. It was intended at first to present keys to the whole order, but due to our lack of material in certain genera and to the extreme uniformity of the genera of the *Coenagrionidae*, we have decided to delay publication of the section on *Zygoptera* until more material and time for study are available.

It is our hope that these keys will be useful particularly to students of aquatic biology and to those engaged in the study of foods of fish and aquatic birds. We are grateful for the constructive criticism coming from the many students in various entomological classes and to the workers in food analysis who have used this key. We are particularly indebted to Dr. E. M. Walker for his examination and much constructive criticism of this manuscript. Thanks are due to the University of Michigan Museum of Zoology for the loan of much material used in the preparation of these keys. Any criticisms or corrections from students using these keys will be gratefully received by the authors.

The following key is most successful with late instar nymphs. Also nymphs killed and preserved in 95 per cent ethyl alcohol have proven to be more satisfactory for examination and identification than specimens killed or preserved in some other manner.

---

[1] Now with the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Panama City, Florida.

KEYS TO GENERA FOR NYMPHS OF ANISOPTERA (ODONATA) OF THE UNITED STATES AND CANADA

KEY TO SUB-ORDERS AND FAMILIES OF THE ODONATA

1. External gills present in the form of three flat triangular vertical plates at end of abdomen; head wider than thorax and abdomen (6A)................. Suborder ZYGOPTERA. 2
External gills absent; head not wider than abdomen and thorax (1A), Suborder ANISOPTERA. 4
2. First antennal (6E) segment as long as the six succeeding segments together; mentum with a deep and open median cleft (6D)................................ AGRIONIDAE
Antennal segments all of approximately the same size (6A); mentum entire or with a closed median cleft (6F).. 3
3. Mentum with a median closed cleft; the mentum spoon shaped, its base reaching to mesothoracic coxae or beyond (6B)................................ LESTIDAE
Mentum entire, without a median cleft; mentum flat, not spoon shaped, its base not reaching much beyond prothoracic coxae (6C)................ COENAGRIONIDAE
4. Labium flat, or nearly so; without stout setae on the mentum (3P)..................... 5
Labium spoon shaped, covering the face to the base of the antennae (1F); mentum armed with stout setae (3L).. 7
5. Antennae 4-segmented (3 C, D, E); pro and metatarsi with but 2 segments (1A), GOMPHIDAE
Antennae 6- or 7-segmented (3 A, B); all tarsi with 3 segments (with the exception of *Gomphaeschna* in which the fore tarsi have but 2 segments)........................ 6
6. Antennal segments short, thick, and heavily setiferous (3B); a pair of latero-dorsal tufts of long black bristles on abdominal segments 2 or 3 to 9 (4K)........ PETALURIDAE
Antennal joints slender and bristle-like (3A); no latero-dorsal abdominal hair tufts present, AESHNIDAE
7. Distal edge of lateral lobe with large, irregular teeth (3H); mentum with a median cleft, CORDULEGASTERIDAE
Distal edge of lateral lobe entire, or with small, even-sized crenulations or teeth (3I); mentum lacking a median cleft................................ LIBELLULIDAE

Family PETALURIDAE

There are but two genera of this family known from the United States and each is represented by but a single species. Only the nymph of the eastern species is at present known.

The species are: *Tanypteryx hageni* Selys (western) and *Tachopteryx thoreyi* Hagen (eastern).

Family GOMPHIDAE

KEY TO GENERA

1. Tenth abdominal segment nearly as long as all other abdominal segments combined (4 E), **Gomphoides williamsoni**
Tenth abdominal segment shorter than eighth and ninth abdominal segments combined (4 A–D).. 2
2. Mesocoxae closer together at base than procoxae (4 I); fourth antennal segment elongate, as long as first antennal segment (3 E).............................. **Progomphus**
Procoxae and mesocoxae approximately same distance apart at their bases (4 J); fourth antennal segment never as above, usually a small rounded knob (3 C, D). 3
3. Wing cases divergent not parallel with meson (1 C)................................ 4
Wing cases parallel with meson (1 A).. 5
4. Dorsal hooks present on abdominal segments 2 or 3 to 9; those on the caudal segments being hook-like and curved dorsad.............................. **Ophiogomphus**
Dorsal hooks present only on abdominal segments 2 to 4; segments 8 and 9 may have a slight thickening on the mid-dorsal line, but these are never as described above, **Erpetogomphus**

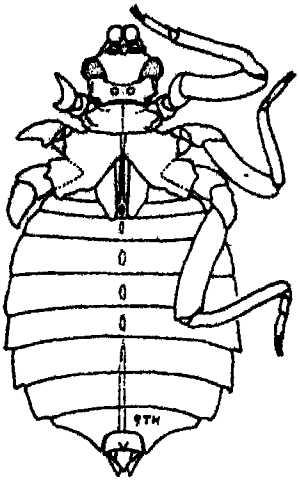
EXPLANATION OF PLATE 1

ANISOPTERA

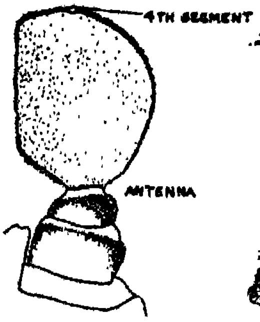
A. Dorsal view of *Hagenius*.
B. Antenna of *Hagenius*.
C. Dorsal view of *Ophigomphus*.
D. Antenna of *Lanthus*.
E. Dorsal view of *Epicordulia*.
F. Lateral view of *Epicordulia*.

ODONATA - ANISOPTERA PLATE I.

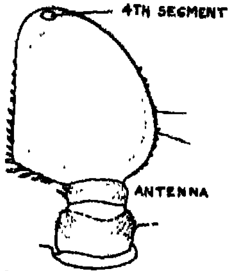
NYMPHS AND ANTENNAE



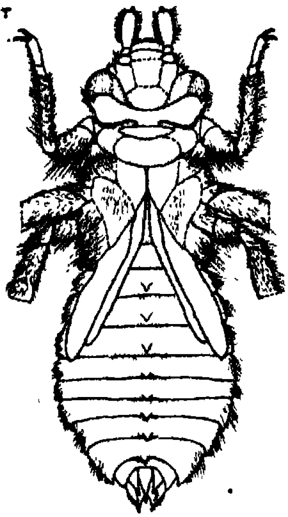
A. HAGENIUS
DORSAL VIEW



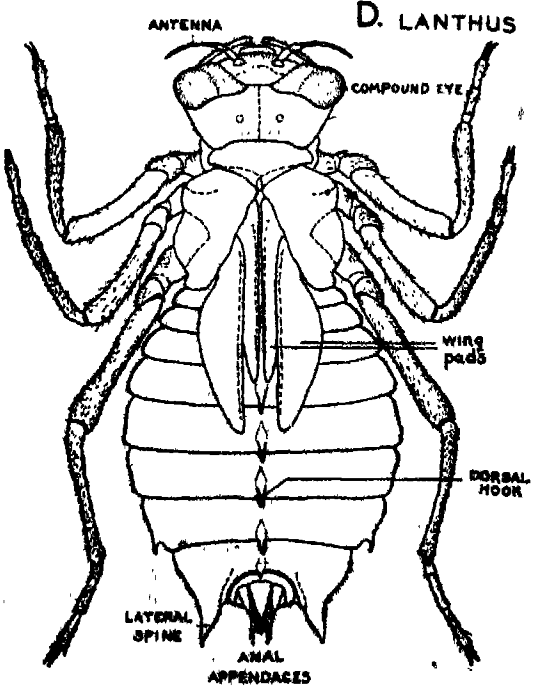
B. HAGENIUS



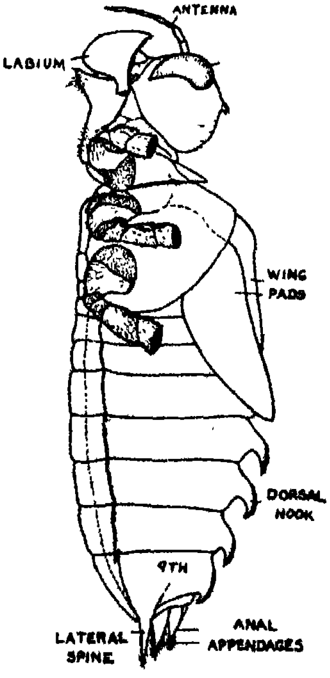
D. LANTHUS



C. OPHIOGOMPHUS
DORSAL VIEW



E. EPICORDULIA
DORSAL VIEW



F. EPICORDULIA
LATERAL VIEW

5. Third antennal segment thin, flat, and suboval (1 B, D) 6
   Third antennal segment elongate or linear, usually cylindrical (3 C) 8
6. Body depressed; abdomen subcircular, almost as wide as long (1 A) .... **Hagenius**
   Body not so depressed; abdomen twice as long as wide (1 C) 7
7. Short lateral spines present on abdominal segments 7 to 9; third antenna, segment narrow, about twice as long as wide (3 D) .... **Octogomphus**
   Short lateral spines present on abdominal segments 8 and 9; third antennal segment wide, fully as wide as long (1 D) .... **Lanthus**
8. Abdominal segment 9 rounded dorsally and without a sharp apical spine (= dorsal hook); or, if a dorsal hook is present on abdominal segment 9, then the segment is longer than wide at its base (4 C, D) .... **Gomphus**
   Abdominal segment 9 with an acute mid-dorsal ridge with a spine (= dorsal hook) at its apex; this segment never as long as wide at its base (4 A, B) 9
9. Lateral anal appendages as long as the superior appendage; fourth antennal segment a conspicuous upturned conic rudiment about as long as the second segment. . **Gomphoides**
   Lateral anal appendages never more than three-fourths the length of the superior appendage (4 A); fourth antennal segment a small round structure, not as described above (3 C) .... **Dromogomphus**

Family AESHNIDAE

KEY TO GENERA

1. Lateral lobes of labium with stout lateral setae .... **Gynacantha, Triacanthagyna**
   Lateral lobes lacking any lateral setae (3 O, P) 2
2. Protarsi with 2 segments, meso and metatarsi with 3 segments .... **Gomphaeschna**
   All tarsi with 3 segments 3
3. Distal border of mentum with a pair of sharp, parallel spines, one on each side of the mental cleft (3 O) .... **Coryphaeschna**
   Distal border of mentum not so armed (3 P) 4
4. Lateral spines present on abdominal segment 7 to 9, (*see Note 2*) .... **Anax**
   Lateral spines present on abdominal segments 4, 5 or 6 to 9 5
5. Caudo-lateral margin of head from dorsal view with two large, well-developed tubercles (2 L); apex of superior anal appendage truncate or but feebly emarginate (4 H); eyes small, occupying only one-third of the lateral margin of the head (2 L) 6
   Caudo-lateral margin of head from dorsal view never with two tubercles as described above (2 K); apex of superior anal appendage deeply emarginate (4 F, G); eyes large, occupying about half of the lateral margin of the head (2 K) 7
6. Low but distinct dorsal hooks (best seen from lateral view) present on abdominal segments 7 to 9 (4 H); apex of lateral lobe broadly rounded; lateral anal appendages less than half the length of the superior .... **Nasiaechna**
   Dorsal hooks absent on all abdominal segments; apex of lateral lobe truncate; lateral anal appendages more than half the length of the superior .... **Epiaeschna**

Note 2. Two species of the genus *Aeshna* (*A. caerulea* Burm. and *A. sitchensis* Hagen) have lateral spines on segments 7 to 9 only. They would thus key out to Anax. Calvert (1934) reports an occasional individual of *Anax junius* with small lateral spines on segment 6. The larger size of the Anax nymphs should be indicative, but the following characters are useful when in doubt (applicable to fully or nearly grown individuals). *Anax*—superior anal appendage but slightly shorter than inferior; inferiors about one and one-half times as long as mid-dorsal length of segments 9 and 10; male appendate (on dorsum of superior appendage) truncate or concave at apex and half or less than half the length of the lateral appendages; ovipositor (in *A. junius*) only about two-thirds the length of segment 9, not reaching hind margin of 9. *Aeshna*—(lateral spines on segments 7 to 9 only); superior appendage about one-fourth shorter than inferiors; inferiors about subequal in length to mid-dorsum of segments 9 and 10; male appendage triangular with a blunt, rounded apex and about three-fourths as long as lateral appendages; ovipositor reaching to proximal third or fourth of segment 10.

EXPLANATION OF PLATE 2

ANISOPTERA

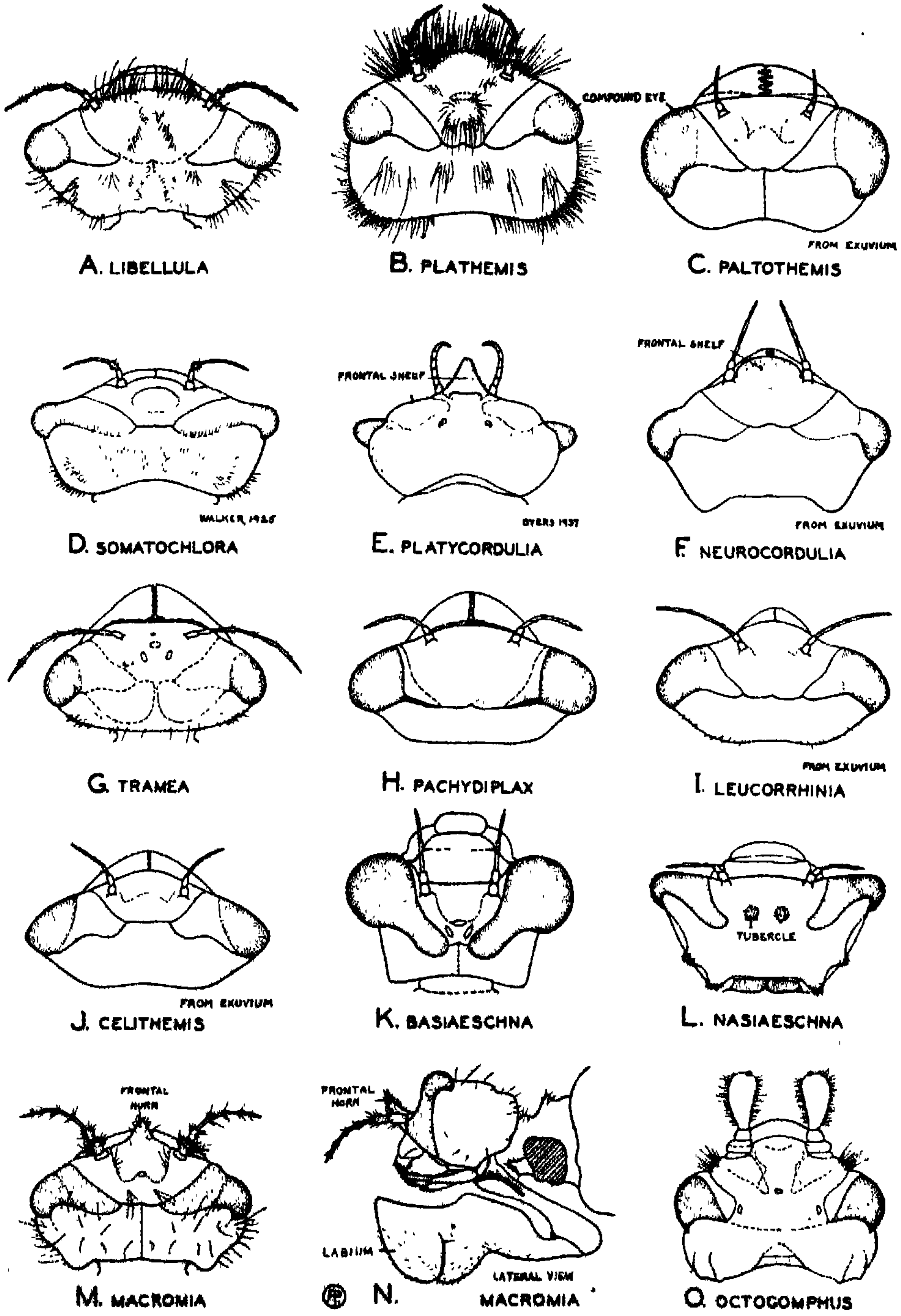
Heads, all dorsal views except figure N.

A. *Libellula.*
B. *Plathemis.*
C. *Paltothemis.*
D. *Somatochlora.*
E. *Platycordulia.*
F. *Neurocordulia.*
G. *Tramea.*
H. *Pachydiplax.*
I. *Leucorrhinia.*
J. *Celithemis.*
K. *Basiaeschna.*
L. *Nasiaeschna.*
M. *Macromia.*
N. *Macromia*, lateral view
O. *Octogomphus.*

ODONATA - ANISOPTERA

HEADS - DORSAL

PLATE 2.



A. LIBELLULA

B. PLATHEMIS

C. PALTOTHEMIS (FROM EXUVIUM)

D. SOMATOCHLORA (WALKER 1925)

E. PLATYCORDULIA (BYERS 1937)

F. NEUROCORDULIA (FROM EXUVIUM)

G. TRAMEA

H. PACHYDIPLAX

I. LEUCORRHINIA (FROM EXUVIUM)

J. CELITHEMIS (FROM EXUVIUM)

K. BASIAESCHNA

L. NASIAESCHNA

M. MACROMIA

Ⓡ N. LATERAL VIEW MACROMIA

O. OCTOGOMPHUS (KENNEDY 1917)

7. *Lateral spines present on abdominal segments 6 to 9; if there is a small spine on segment 5 then the caudo-lateral margin of the head is rounded and the lateral anal appendages one-half or greater than one-half the length of the inferiors (see Note 8)*............**Aeshna**
   Lateral spines present on abdominal segments 4 or 5 to 9; caudo-lateral margins of the head distinctly angulate, or, if obtusely angulate or rounded, then the lateral anal appendages are but one-fourth the length of the inferiors............................7
8. Lateral lobe of labium obtuse or subtruncate at tip (3 F); median border of lateral lobe with distinct, more or less square-cut teeth..................................**Boyeria**
   Lateral lobe of labium with a taper pointed tip (3 G); median border of lateral lobe with indistinct denticulation..................................**Basiaeschna**
9. Nymphs unknown..................................**Oplonaeschna**

Family CORDULAEGASTERIDAE

The majority of the papers found in the literature include all species of this group found in our fauna in one genus, Cordulaegaster. Byers (1930), however, lists three genera. His discussion of this family is worthy of note and is to be found on pages 82 to 89 in his monograph.

Family LIBELLULIDAE

KEY TO SUBFAMILIES

1. Head with a prominent frontal horn between the bases of the antennae (2 M, N), **Macromiinae**
2. Head without such a projection (2 A, D)..................**Corduliinae, Libellulinae**

Subfamily MACROMIINAE

KEY TO GENERA

1. Lateral spines of ninth abdominal segment reaching less than half way to apex of anal appendages (5 A); cephalic margin of head noticeably wider than caudal margin (2 M), **Macromia**
   Lateral spines of ninth abdominal segment reaching to apex of anal appendages (5 B); cephalic and caudal margins of head subequal in width..................**Didymops**

Subfamilies CORDULIINAE and LIBELLULINAE

There are no points which will separate all of the members of one subfamily from all of the members of the other subfamily, hence the genera are keyed out together. In compiling this key liberal use has been made of many sources, the most important among them being Byers (1936) and Needham (1936).

KEY TO GENERA

1. Abdomen with dorsal hooks or knobs present on one or more segments..................2
   Abdomen with dorsal hooks or knobs absent on all segments..........................21
2. A dorsal hook or knob present on abdominal segment 9..............................3
   No dorsal hook or knob present on segment 9..12
3. *Lateral spines of abdominal segment 9 reaching to or beyond the tips of the anal appendages (1 E, F; 5 C)*..4
   Lateral spines of segment 9 short, not reaching to tip of anal appendages (5 E–H).........7
4. Lateral spines of segment 8 set at an angle to the long axis of the abdomen, not parallel to those of segment 9 (5 C, D)..5
   Lateral spines of segment 8 not at an angle, usually parallel to those of segment 9 (1 E)...6

EXPLANATION OF PLATE 3

ANISOPTERA

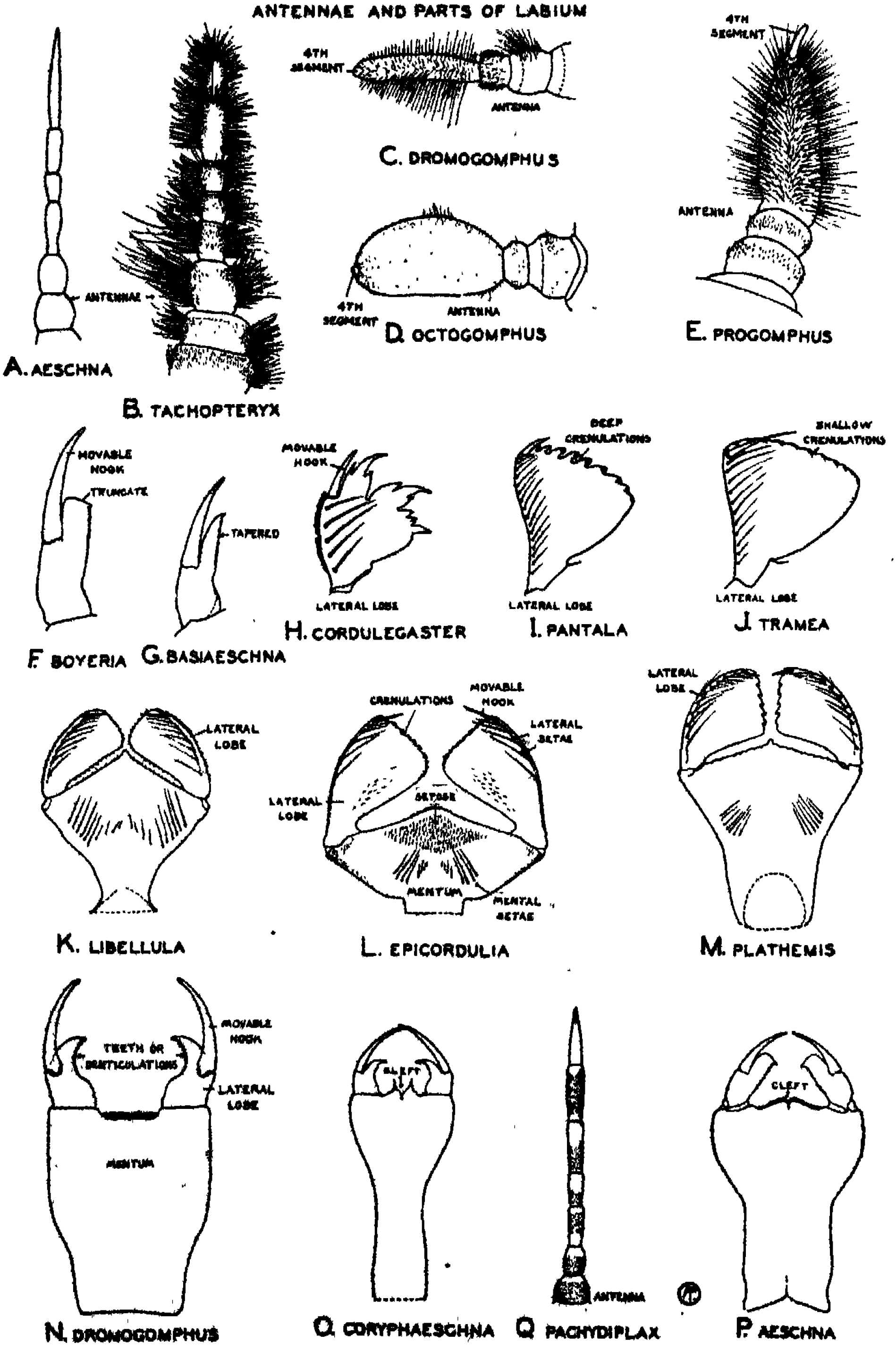
A. Antenna of *Aeschna.*
B. Antenna of *Tachopteryx.*
C. Antenna of *Dromogomphus.*
D. Antenna of *Octogomphus.*
E. Antenna of *Progomphus.*
F. Lateral lobe of *Boyeria.*
G. Lateral lobe of *Basiaeschna.*
H. Lateral lobe of *Cordulegaster.*
I. Lateral lobe of *Pantala.*
J. Lateral lobe of *Tramea.*
K. Mentum and lateral lobes of *Libellula.*
L. Mentum and lateral lobes of *Epicordulia.*
M. Mentum and lateral lobes of *Plathemis.*
N. Mentum and lateral lobes of *Dromogomphus.*
O. Mentum and lateral lobes of *Coryphaeschna.*
P. Mentum and lateral lobes of *Aeschna.*
Q. Antenna of *Pachydiplax.*

Figures K to P show dorsal surface (inner surface of mentum when labium is at rest).

ODONATA - ANISOPTERA

PLATE 3.

ANTENNAE AND PARTS OF LABIUM



5. Frontal shelf, between bases of the antennae, produced into a prominent flat triangle (2 E), **Platycordulia**
   Frontal shelf, between bases of the antennae, low and rounded, not produced into a flat triangle (2 F)........ **Neurocordulia**
6. Distal half of dorsal surface of mentum heavily setose; lateral setae 4 to 5 (3 L), **Epicordulia**
   Distal half of dorsal surface of mentum with few or generally no setae; lateral setae 6 to 8, **Tetragoneuria**
7. Superior and inferior anal appendages long; as long as mid-dorsal length of abdominal segments 8 and 9 (5 E)........ **Cannacria**
   Superior and inferior anal appendages short; shorter than mid-dorsal length of abdominal segments 8 and 9, usually not longer than mid-dorsal length of either segment (5 H), 8
8. Lateral anal appendages nearly as long as the superior appendge........ 9
   Lateral anal appendages one-half or less the length of superior appendage........ 10
9. Dorsal hooks absent on segments 3 to 4, crenulations of the lateral lobes deep (3 I), **Helocordulia**
   Dorsal hooks present on segments 3 and 4; crenulations of lateral lobes shallow (3 J), **Somatochlora**
10. Mental setae 9–10; length when full grown less than 18 mm.; dorsal hooks on segments 3–9........ 11
    Mental setae 14–15; length 24 mm. when full grown; dorsal hooks on segments 2–9, **Brechmorhoga**
11. Lateral setae 5, crenulations of distal margin of lateral lobe deep........ **Perithemis**
    Lateral setae 7–10; crenulations of lateral lobe obsolete........ **Dythemis**
12. Eyes at side lateral of head, (2 G, H, I and J, *see Note 3*)........ 13
    Eyes capping the cephalo-lateral angles of the head, more frontal than lateral, (2 A, B and C, *see Note 3*)........ 17
13. Lateral setae 7; lateral anal appendages nearly as long as superior appendage.. **Dorocordulia**
    Lateral setae 7 to 14; lateral anal appendages usually about half the length of the superior appendage........ 14
14. Dorsal hook present on segment 3; inferior anal appendages subequal in length to superior appendage........ 15
    Dorsal hook absent on segment 3; inferior anal appendages markedly longer than superior appendage........ 16
15. Dorsal hook present on segment 2; lateral spines of segment 9 as long or longer than lateral margin of segment........ **Macrodiplax**
    Dorsal hook absent on segment 2; lateral spines of segment 9 one-half or less the length of segment 9; or if as long the apex not curved medially........ **Leucorrhinia** (in part)
16. Lateral spines of abdomen long and straight, those of segment 9 extending to or beyond the tips of the inferior anal appendages........ **Celithemis**
    Lateral spines of abdomen short, not reaching tips of anal appendages, curved toward meson (5 F)........ **Sympetrum** (in part)
17. Inferior and superior anal appendages subequal in length........ 18
    Inferior anal appendages noticeably longer than the superior........ **Sympetrum** (in part)
18. Mental setae 0 to 4........ **Ladona**
    Mental setae 8 to 15 (3 K)........ 19
19. Body smooth; mental setae 14 to 15; low dorsal hooks on segments 2 to 6; crenulations of lateral lobes very deep (3 I)........ **Paltothemis**
    Body hairy; mental setae 8 to 13; dorsal hooks on segments 3 to 6 or 8; crenulations moderate or absent (3 J)........ 20
20. Median lobe of labium crenulate on its distal margin (3 M); abdominal segments 7 to 9 with black, shining mid-dorsal ridges........ **Plathemis**
    Median lobe of labium evenly contoured (3 K); abdominal segments 7 to 9 without such ridges........ **Libellula**

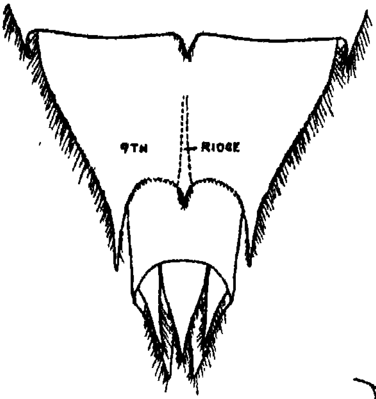
EXPLANATION OF PLATE 4

ANISOPTERA

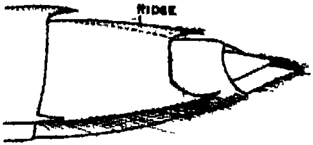
A. Dorsal view of caudal segments of *Dromogomphus*.
B. Lateral view of caudal segments of *Dromogomphus*,
C. Dorsal view of caudal segments of *Gomphus*.
D. Lateral view of caudal segments of *Gomphus*.
E. Dorsal view of caudal segments of *Gomphoides*.
F. Ventral view of caudal segments of *Basiaeschna*.
G. Dorsal view of caudal segments of *Basiaeschna*, parts named.
H. Dorsal view of caudal segments of *Nasiaeschna*.
I. Ventral view of thorax of *Progomphus*.
J. Ventral view of thorax of *Gomphus*.
K. Dorsal view of caudal segments of *Tachopteryx*.

ODONATA - ANISOPTERA PLATE 4.

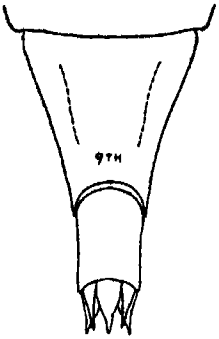
CAUDAL SEGMENTS &c



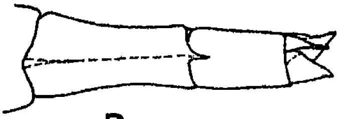
A. DROMOGOMPHUS
DORSAL VIEW



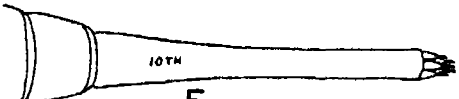
B. DROMOGOMPHUS
LATERAL VIEW



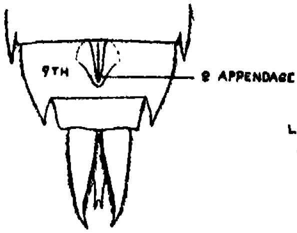
C. GOMPHUS
DORSAL VIEW



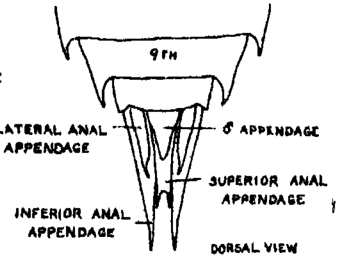
D. GOMPHUS
LATERAL VIEW



E. GOMPHOIDES
DORSAL VIEW

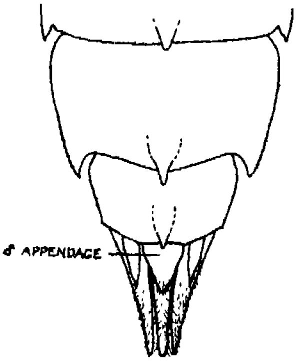


F. BASIAESCHNA
VENTRAL VIEW

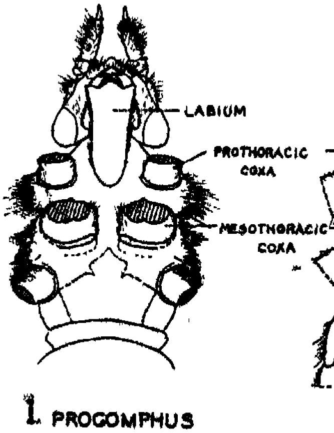


DORSAL VIEW

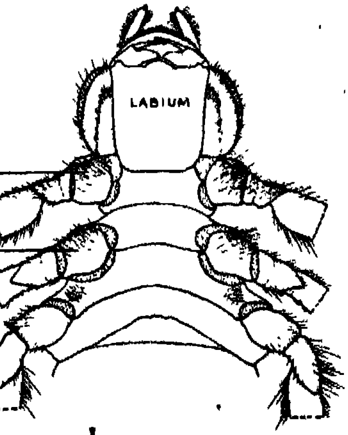
G. BASIAESCHNA



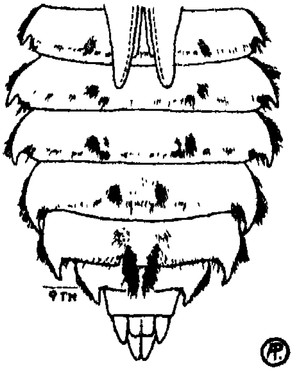
H. NASIAESCHNA
DORSAL VIEW



I. PROGOMPHUS
VENTRAL VIEW



J. GOMPHUS
VENTRAL VIEW



K. TACHOPTERYX
DORSAL VIEW

21. Apical third of inferior and lateral anal appendages strongly decurved (5 G) 22
Apical third of all anal appendages straight, not decurved ventrally (5 I) 23
22. A minute lateral spine on abdominal segment 9; lateral setae 11 or 12 .... **Lepthemis**
No lateral spines on abdomen; lateral setae 7 to 9 .... (=**Mesothemis**) **Erythemis**
23. Eyes capping the cephalo-lateral angles of the head, usually small and not very prominent (2 A, B and D, *see Note 3*) 24
Eyes at the side lateral of the head, large and prominent on a usually triangular shaped head (2 G, H and I, *see Note 3*) 29
24. Lateral anal appendages nearly as long as the superior 25
Lateral anal appendages one-third to one-half as long as the superior; crenulations of lateral lobes shallow or absent (3 J) 27
25. Crenulations of the distal margin of the lateral lobe obsolete, merely indicated by about fifteen single spinules .... **Pseudoleon**
Crenulations of the distal margin of the lateral lobe deep with groups of 2–7 spinules on each tooth 26
26. A dark longitudinal stripe present along the dorso-lateral margins of the thorax ... **Cordulia**
Thorax unicolored, no such stripe present .... **Somatochlora** (in part)
27. Lateral spines present on abdominal segments 8 and 9 28
Lateral spines present only on abdominal segment 9 .... **Tarnetrum**
28. Mentum with distal margin crenulate (3 M); abdominal segments 4 to 7 with dorsal tufts of long hair .... **Orthemis**
Mentum with distal margin entire, evenly contoured (3 K); abdominal segments 4 to 7 not as above .... **Libellula**
29. Anal appendages long, slender and needle-pointed; lateral spines of segments 8 and 9 long and curved toward meson, those on segment 8 at least as long as mid-dorsal length of segment 9 (5 J, K) 30
Anal appendages short and heavy, not projected into a long, needle-point; lateral spines on segments 8 and 9 flat and straight, those on 8 not as long as mid-dorsal length of segment 9 (5 I) 31
30. Lateral spines of abdominal segment 8 but slightly shorter than those of segment 9; lateral spines of segment 9 reaching tips of anal appendages (5 J): crenulations of distal margin of lateral lobe shallow (3 J) .... **Tramea**
Lateral spines of abdominal segment 8 only one-third size of those of segment 9; lateral spines of segment 9 not reaching tips of anal appendages (5 K); crenulations of distal margin of lateral lobe deep (3 I) .... **Pantala**
31. Lateral setae 6 to 7; lateral anal appendages more than half as long as the inferiors 32
Lateral setae 9 to 14; lateral anal appendages less than half as long as inferiors 33
32. Lateral setae 6; mental setae 9 to 11; inferior and superior anal appendages subequal in length .... **Nannothemis**
Lateral setae 7; mental setae about 14; inferior anal appendages longer than superior appendage .... **Cordulia**
33. Lateral spines absent on segment 8 .... **Tarnetrum**
Lateral spines present on segment 8 34
34. Lateral spines of abdominal segments 8 and 9 subequal in length; some species with prominent bunches of setae present on the dorsum of abdominal segments 4 to 9, **Erythrodiplax**
Lateral spines of abdominal segments 8 and 9 unequal in length; those of segment 8 about half those of segment 9; never with prominent bunches of setae as described above (5 I) 35
35. Lateral spines of segment 9 equal to or greater than the mid-dorsal length of segment 9 (5 I); antennae colored black and white (3 Q); a dark colored ridge running mesad from meso-caudal portion of eye (2 H) .... **Pachydiplax**
Length of lateral spines of segment 9 less than the mid-dorsal length of segment 9; antennae not colored as above; no ridge running mesad from eyes as described above (2 I) .... **Leucorrhinia** (in part)
36. Nymphs unknown .... **Williamsonia**

Note 3. In certain cases the position of the eyes on the head is a difficult point to determine; in such instances the specimens should be run through both forks of the key.

EXPLANATION OF PLATE 5

ANISOPTERA

Caudal segments of abdomen, all dorsal views except G.

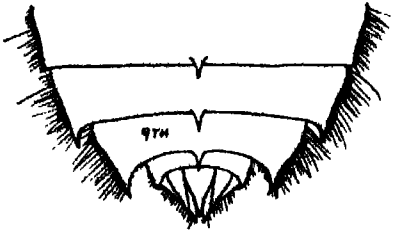
A. *Macromia.*
B. *Didymops.*
C. *Neurocordulia obsoleta* Say.
D. *Neurocordulia yamaskanensis* Prov.
E. *Cannacria.*
F. *Sympetrum.*
G. *Mesothemis*, lateral view.
H. *Perithemis.*
I. *Pachydiplax.*
J. *Tramea*, parts named.
K. *Pantala.*

ODONATA - ANISOPTERA

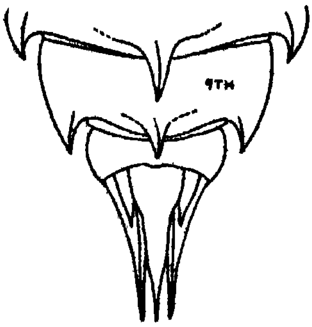
PLATE 5.

CAUDAL SEGMENTS

DORSAL VIEWS

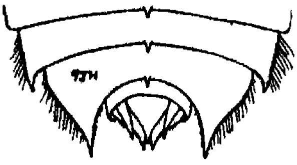


A. MACROMIA

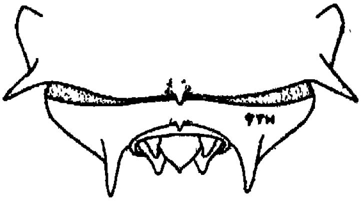


BYERS 1936

E. CANNACRIA

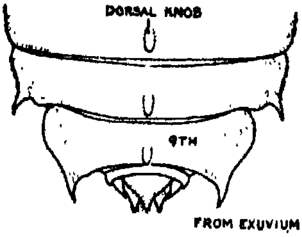


B. DIDYMOPS

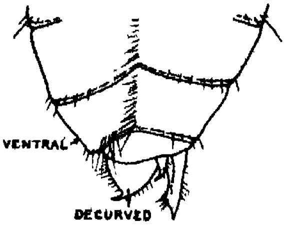


BYERS 1937

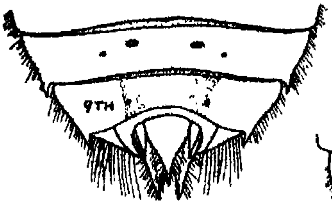
C. NEUROCORDULIA OBSOLETA



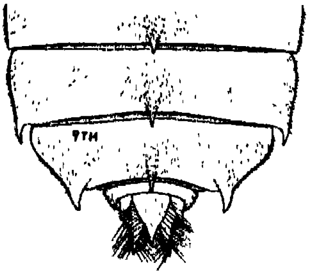
D. NEUROCORDULIA YAMASKANENSIS



G. MESOTHEMIS x LATERAL VIEW

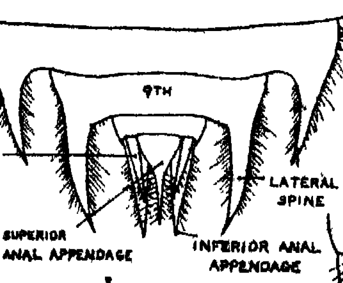


F. SYMPETRUM

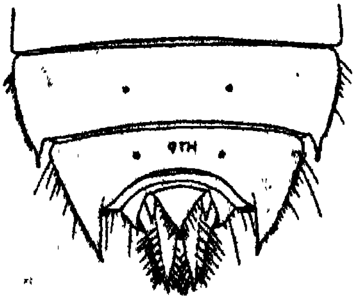


H. PERITHEMIS

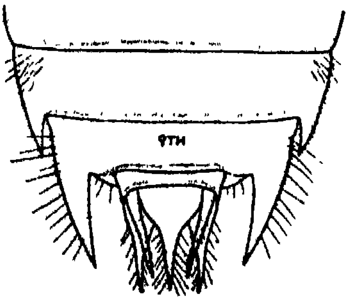
LATERAL ANAL APPENDAGE



J. TRAMEA



I. PACHYDIPLAX



K. PANTALA

Ⓟ

GLOSSARY

Acute—A ridge or projection sharply pointed at apex (4 A and B).

Anal appendages—the five movable appendages (4 G and 5 J) borne on the distal end of the abdomen, namely: superior (1); inferior (2); lateral (2). See further discussion under each.

Angulate—produced into an angle, used in describing the contours of head and body surfaces. (2 K).

Apex (apical)—the distal portion or end of an appendage.

Base (basal)—the proximal portion or base of an appendage.

Cleft—On the labium a longitudinal split present on the meson of the mentum, referred to as mental or median cleft 3 O and P.

Conic—A short, knob-like structure, used here in describing the fourth antennal segment of certain Gomphines (3 C and D).

Contour—The outline or periphery of surfaces.

Crenulate—having small blunt teeth (scallops) which are evenly rounded and rather deeply curved (3 I and J).

Crenulations—the name applied to the individual small rounded teeth described above.

Cylindrical—elongate and round, used in describing appendages (3 C, third segment).

Decurved—bent or curved downward (ventrally). Used to describe anal appendages of certain genera (5 G).

Denticulate—having small usually sharp pointed teeth (3 N).

Denticulation—term applied to an individual tooth described above.

Depressed—flattened dorso-ventrally.

Divergent—not parallel, projecting away from the median line. Used to describe certain wing pads and lateral spines. (Plate 1, compare wing pads of fig. C with those of fig. E and plate 5 C, see lateral spines of segment 8).

Dorsal hook—a stout usually prominent spine located on the mid-dorsal line of the abdominal segments (1 E and F). In some cases these may be knob-like (5 D).

Elongate—lengthened, much longer than wide. Compare 10th abdominal segments of 4 E and 4 G.

Emarginate—with an obtuse, rounded or quadrate section cut from a margin. See superior appendages of 4 F and G

Entire—with an even, unbroken margin and not denticulate or crenulate, note distal margin of mentum (3 L).

External gills—present in the Zygoptera These are the tracheal gills in the form of three flat or triangular, elongate plates borne on the caudal end of the abdomen. They consist of one median and two lateral gills (6 A and C).

Frontal horn—a pyramidal projection of the forehead located between the bases of the antennae (2 M and N).

Inferior anal appendages—a pair of identical structures borne on the ventro-caudal margin of the tenth abdominal segment, morphologically they are the paraprocts (subanal or podical plates) (4 G and 5 J).

Lateral anal appendages—a pair of identical structures borne on the laterio-caudal margins of the tenth abdominal segment, morphologically these are the cerci (4 G and 5 J).

Lateral lobe—a pair of variably shaped segments articulated to the disto-lateral margins of the mentum of the labium, see various figures 3 F to O.

Lateral setae—long, stout setae borne on the latero-dorsal margins of the lateral lobes (3 H to M).

Lateral spines—spine-like projections from the caudo-lateral margins of certain abdominal segments (4 G and 5 J).

Mentum—The most distal unpaired section of the labium usually bearing distinct lateral lobes. Among higher odonates it is broad, curved and spoon-shaped (3 K to O).

Mental setae—a prominent row of strong setae borne on each proximal half of the dorsal (ental) surface of the mentum. The two rows are usually identical in number and structure (3 K to M).

Mesad—Towards the median plane (or line) of the body.

Meson—the median plane (or line) of the body.

Obsolete—almost or entirely lacking; not fully developed. Used to describe crenulations of the lateral lobes of certain forms. Compare 3 I and 3 J.

Obtuse—not pointed; at an angle greater than a right angle.

Setose—thickly covered with setae (3 B, E and L).

Sub—The prefix *sub* is used to denote that the structure described is almost as noted; i. e., subcircular, suboval, subequal, subtruncate, etc.

Superior appendage—an unpaired structure borne on the mid-dorso-caudal margin of the tenth abdominal segment, morphologically the epiproct (supra-anal plate), (4 G and 5 J).

Taper-pointed—with a sharp point which may curve somewhat (3 G).

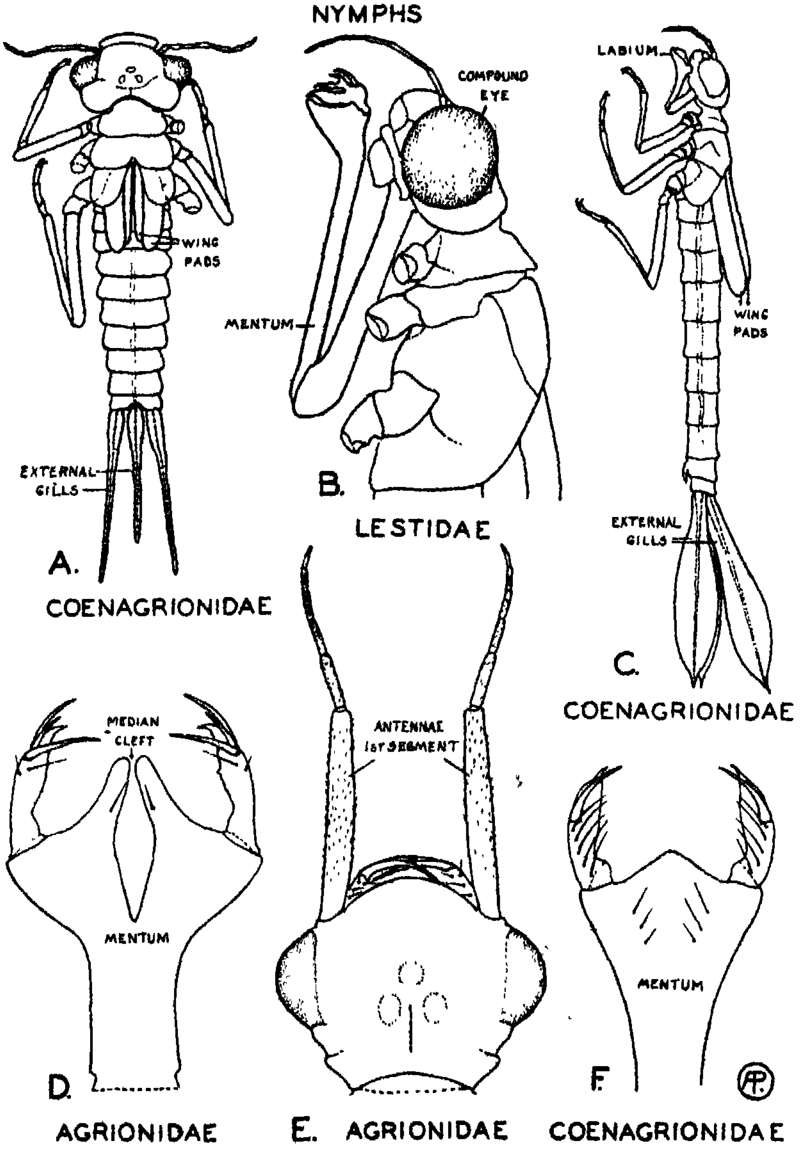
Terminal abdominal segments—segments 8, 9, and 10.

Teeth—see crenulations.

Truncate—cut off squarely at tip (3 F).

Tubercle—a rounded knob-like projection of the head or body surface (2 L).

ODONATA - ZYGOPTERA PLATE 6.



EXPLANATION OF PLATE 6

ZYGOPTERA

A. *Coenagrionidae*, dorsal view.
B. *Lestidae*, lateral view of cephalic end.
C. *Coenagrionidae*, lateral view.
D. *Agrionidae*, mentum and lateral lobes.
E. *Agrionidae*, dorsal view of head.
F. *Coenagrionidae*, mentum and lateral lobes.

REFERENCES TO THE LITERATURE AVAILABLE FOR IDENTIFICATION OF SPECIES OF THE ANISOPTEROUS DRAGONFLIES OF THE UNITED STATES AND CANADA

PETALURIDAE

Tachopteryx	Selys-Williamson (1901); Needham (1929).

GOMPHIDAE

Progomphus Selys	Byers (1939). Excellent study of the genus.
Hagenius Selys	A single species, *H. brevistylus* Selys.
Ophiogomphus Selys	Kennedy (1917) and Walker (1933). Excellent.
Octohomphus Selys	A single species, *O. specularis* Hagen.
Gomphoides Selys	There are but two species at present listed under this genus: *G. williamsoni* Gloyd with the elongate tenth abdominal segment; and *G. stigmata* Say with the tenth segment normal and known only from Texas.
Erpetogomphus Selys	There are four species in our area of which *E. designatus* been described from raised material by Hagen (1885) and *E. compositus* by supposition, see Hagen (1885).
Dromagomphus Selys	Three known species. Only one, *D. spinosus* Selys has been described. See Garman (1927) or Byers (1930).
Lanthus Needham	Two known species. One, *L. parvulus* Selys, described from supposition by Needham (1901).
Gomphus Leach	This is the largest genus in our fauna, and many of the nymphs are as yet unknown. Several regional publications are of considerable value, but the collector must at all times remember that many of the species are unknown in the nymphal stage. Nymphs of this genus should be checked by some authority. The following papers may be consulted: Needham and Heywood (1929) general; Kennedy (1917) western forms; Byers (1930) southeast; Garman (1927) New England; and Walker (1928) for the subgenus *Stylurus*.

AESHNIDAE

Gomphaesechna Selys	Two species in our fauna. The generic characters of the genus are briefly indicated by Martin (1940).
Basiaeschna Selys	A single species—*B. janata* Say.
Boyeria McLachlan	Two species. Garman (1927), and Walker (1913 and 1915).
Anax Leach	Byers (1927) and Calvert (1934).
Oplonaeschna Selys	A single species, *O. armata* Hagen. Nymph unknown.
Coryphaeschna Williamson	Two species in our fauna. Kennedy (1919) described the nymph of *C. ingens* Rambur. *C. virens* Rambur is unknown in the nymphal stage.
Nasiaeschna Selys	A single species, *N. penthacantha* Rambur.
Epiaeschna Hagen	A single species, *E. heros* Fabricius.
Aeshna Illiger	Composed of 18 species of which nymphs have been described for 15. See Walker (1912, 1914, 1921, 1934, and 1941) and Kennedy (1917).
Gynacantha Rambur	Probably but a single species in our fauna, *G. nevrosa*, Rambur, which is illustrated by Williams (1937). *G. bifida* Rambur has been recorded from Florida but according to Byers (1930) an examination of material and reports leads to the belief that all such records were based on misidentification of *G. nervosa*.
Triacanthagyna Selys	A single species in our fauna, *T. trifida* (Rambur). Nymph unknown, but probably generaically similar to *Gyncantha*.

CORDULEGASTERIDAE

Cordulegaster Leach	Eight species have been recorded from our fauna. Needham and Heywood (1929) give a key to the nymphs of six of these. Kennedy (1917) gives excellent descriptions and illustrations of the two far western species. Byers (1930) describes the southern form.

LIBELLULIDAE

Macromiinae

Macromia Rambur	Nine species, known from our fauna. The nymphs of four are known. Needham and Heywood (1929); Kennedy (1917) excellent illustrations; and Walker (1937) excellent illustrations.
Didymops Selys	Two species. *D. transversa* Say well described by Byers (1930) and Garman (1927. *D. floridensis* Davis nymph unknown.

Cordulinae

Platycordulia Williamson	A single species, *P. xanthasoma* Williamson.
Neurocordulia Selys	See Byers (1937).
Epicordulia Selys	Two species. Needham and Heywood (1929).
Tetragoneuria Hagen.	The number of species in this genus is open to question. Very little dependence can be placed on nymphal determinations other than generic. Needham and Heywood (1929); Garman (1927); Byers (1930).
Helocordulia Needham	Two species. Needham (1901) Needham and Heywood (1929) and Kennedy (1924).
Somatochlora Selys.	A large genus. Walker (1925) wrote an excellent monograph on the genus bringing all information up to that date. Several new species and a few nymphs have been described since.
Cordulia Leach	A single species, *C. shurtleffi* Scudder.
Dorocordulia Needham	Two species. See Garman (1927).
Williamsonia Davis.	Two species. The nymphs of both unknown.

Libellulinae

Nannothemis Brauer	A single species, *N. bella* Uhler.
Perithemis Hagen	Two species in our fauna: *P. tenera* Say U. S., described by Garman (1927) as *P. domitia*; and *P. seminole* Calvert from Florida, see Byers (1930).
Celithemis Hagen	Eight species. The nymphs are but poorly known. See Needham and Heywood (1929), Garman (1927), and Byers (1930).
Pseudoleon Kirby.	A single species, *P. superbus* Hagen. See Needham (1937).
Erythrodiplax Brauer	Needham (1929) and Borror (1942).
Orthemis Hagen	A single species in our fauna, *O. ferruginea* Fabr.
Ladona Needham	Needham and Heywood (1929), Garman (1927), and Byers (1930).
Libellula Linnaeus	A large genus. Byers (1927a) gives very good keys to the known species. Consult also Needham and Heywood (1929) and Garman (1927).
Plathemis Hagen	Two species. Only the nymph of *P. lydia* Drury is known. See Needham (1901).
Cannacria Kirby	A single species in our fauna, *C. gravida* Calvert. Well illustrated by Byers (1936).
Sympetrum Newman	A large rather difficult genus. Consult Walker (1917) and Needham and Heywood (1929).
Leucorrhinia Brittinger	See Walker (1916, 1940) and Needham and Heywood (1929).
Pachydiplax Brauer	A single species, *P. longipennis* Burmeister.
Erythemis Hagen (= *Mesothemis*).	Two species. Only the nymph of *E. simplicicollis* Say known.
Lepthemis Hagen	A single neotropical species which barely enters our southern border, *L. vesiculosa* Fabricius.
Dythemis Hagen	See Needham and Heywood (1929) and Byers (1930).
Brechmorhoga Kirby	See Needham and Fisher (1936). A single Sonoran species in our southwestern border, *B. mendax* Hagen.
Paltothemis Karsch	A single species along the southwestern border of our area, *P. lineatipes* Karsch.
Pantala Hagen	Two species. Needham and Heywood (1929), Garman (1927) and Kennedy (1923).
Macrodiplax Brauer	A single species in our fauna, *M. balteata* Hagen.
Tramea Hagen	A very difficult genus for specific nymphal determination. Best discussion by Byers (1927b).

REFERENCES CITED

Borror, D. J. 1942. A revision of the libelluline genus Erythrodiplax. Ohio State Univ. Graduate School Studies, Biological Series, Contributions in Zoo. and Ent. No. 4.

Byers, C. F. 1927a. The nymph of *Libellula insecta* and a key for the separation of the known nymphs of the genus Libellula. Ent. News 38: 113.

1927b. Notes on some American dragonfly nymphs. Jour. N. Y. Ent. Soc. 35: 65.

1930. A contribution to the knowledge of Florida Odonata. Univ. Fla. Pub., Bio. Sci. Series No. 1.

1936. The immature form of *Brachymesia gravida* Calvert, with notes on the taxonomy of the group. Ent. News 47: 35.

1937. A review of the dragonflies of the genera Neurocordulia and Platycordulia. Univ. Mich., Museum of Zoo. Misc. Publ. No. 36.

1939. A study of the dragonflies of the genus Progomphus (Gomphoides) with a description of a new species. Proc. Fla. Acad. Sci. 4: 19.

Calvert, P. P. 1934. The rate of growth, larval development and seasonal distribution of dragonflies of the genus Anax. Proc. Amer. Philo. Soc. 73: 1.

Garman, P. 1927. The Odonata or dragonflies of Connecticut. Conn. Geol. and Nat. Hist. Survey Bul. 39.

Hagen, H. A. 1885. Monograph of the earlier stages of the Odonata. Trans. Amer. Ent. Soc. 12: 249.

Kennedy, C. H. 1917. Notes on the life history and ecology of the dragonflies of Central California and Nevada. Proc. U. S. Nat. Museum 52: 483.

1919. The naiad of the Odonata genus Coryphaeschna. Ent. News 30: 105.

1923. The naiad of *Pantala hymenea* Say. Can. Ent. 54: 36.

1924. Notes and descriptions of naiads belonging to the dragonflies genus Helocordulia. Proc. U. S. Nat. Museum 64: 1.

Martin, E. C. 1940. The nymphal skin of Gomphaeschna Selys. Jour. Ala. Acad. Sci. 12, part 2: pp. 66.

Needham, J. G. 1901. On aquatic insects in the Adirondacks. N. Y. State Mus. Bul. 47: 429.

1937. The nymph of *Pseudoleon superbus* Hagen. Reprint from December 1937 issue Pomona College Jour. Ent. and Zoo.

Needham, J. G., and **Heywood, H. B.** 1929. A handbook of the dragonflies of North America. C. C. Thomas, Publisher, Springfield, Illinois.

Needham, J. G., and **Fisher, E.** 1936. The nymphs of North American dragonflies. Trans. Amer. Ent. Soc. 62: 107.

Walker, E. M. 1912. The North American dragonflies of the genus Aeshna. Univ. Toronto Studies, Biol. Series 11.

1913. New nymphs of Canadian Odonata. Can. Ent. 45: 161.

1914. New and little known nymphs of Canadian Odonata. Can. Ent. 46: 349 and 369.

1915. Notes on the Odonata of the vicinity of Go Home Bay, Georgian Bay, Ontario. Suppl. 47th Ann. Rept. Dept. Marine and Fisheries, Fish Branch, 53–94.

1916. Nymphs of the North American species of Leucorrhinia. Can. Ent. 48: 414.

1917. The known nymphs of the North American species of Sympetrum. Can. Ent. 49: 409.

1921. The nymph and breeding place of *Aeshna sitchensis* Hagen. Can. Ent. 53: 221.

1925. The North American dragonflies of the genus Somatochlora. Univ. Toronto Studies, Biol. Series No. 26.

1928. The nymphs of the Stylurus group of the genus Gomphus with notes on the distribution of this group in Canada. Can. Ent. 60: 78.

1933. The nymphs of the Canadian species of Ophiogomphus. Can. Ent. 65: 217.

1934. The nymphs of *Aeshna juncea* L. and *A. subarctica* Wlk. Can. Ent. 66: 267.

1937. A new Macromia from British Columbia. Can. Ent. 69: 5.

1940. Odonata from the Patricia portion of the Kenora District of Ontario, with a description of a new species of Leucorrhinia. Can. Ent. 72: 4.

1941. The nymph of *Aeshna verticalis* Hagen. Can. Ent. 73: 229.

Williams, F. X. 1937. Notes on the biology of *Gynacantha nervosa* Rambur, a crepuscular dragonfly in Guatemala. Pan-Pacific Ent. 13: 1.

Williamson, E. B. 1901. On the manner of oviposition and on the nymph of *Tachopteryx thoreyi* Hagen. Ent. News 12: 1.

THE FRESH-WATER NAIADES OF AUGLAIZE COUNTY, OHIO

CLARENCE F. CLARK,
Ohio Division of Conservation and Natural Resources,
St. Marys, Ohio

This paper deals with 30 collections of mussels taken at 24 stations (Fig. 1) in the drainage systems of Auglaize County during the past four years, 1938–42. The materials are of interest because: (1) no other naiad records have been published for this area; (2) rapid changes in stream ecology necessarily alter the mussel fauna; and (3) the proximity of headwater streams of the Ohio and Lake Erie drainages produce interesting distribution patterns for comparison. In the general vicinity, Goodrich (1914) reported on naiades from the Wabash River in Mercer County; Clark and Wilson (1912) surveyed the Maumee and Auglaize Rivers of Defiance County; Kirsch (1894) investigated the Maumee Basin; Ortmann (1919) reported on mussels from the St. Marys River, Beaver Creek, and Lake St. Marys in Mercer County, the Maumee River in Defiance County, the Scioto River in Hardin County, and Indian Lake in Logan County. These collections have been made in counties to the west, north and east of the region considered at present. Records of Sterki (1907) and those from the Carnegie Museum of Pittsburgh list specimens from the Great Miami drainage to the south. This paper presents data on the origin of the naiades of Auglaize County, the species involved, their distribution and ecology, together with a brief discussion on the future of naiades in the county.

Acknowledgements are due Dr. Henry van der Schalie for assistance in the identification of the specimens used in this study and in the preparation of this paper, and Dr. Stanley Truman Brooks who furnished me with western Ohio records from the Carnegie Museum of Pittsburgh.

PHYSIOGRAPHY OF AUGLAIZE COUNTY

Auglaize County occupies an area of 398 square miles on the top of the watershed between the Ohio and Lake Erie drainages in west central Ohio. During glacial times, the region was buried under the ice. Numerous halts characterized the retreat of the glacier and during these periods large beds of drift were deposited at the ice margin (Hobbs 1921: 311). Such deposits lend a sag and swell aspect to the county characterized by its broad moraines and interlying, rather level, plains. Because of the position of these moraines, the present drainage is in three directions: southward through tributaries of the Great Miami and Scioto Rivers in the eastern and southern parts of the county, northward through the Auglaize River in the center, and westward through the St. Marys River in the western part.

According to Winchell (1894: 406), "The soil of the county is essentially clay. Various local circumstances have caused accidental qualities to modify it." He also indicates that the St. Johns and Wabash moraines are characterized by a gravelly clay soil while that of the St. Marys is "simply a broad undulation, or thickening of the drift," and is composed of coarse heavy clay. Leverett (1902: 522 and 561) indicates that the plains between the ridges have a deep black soil which Dachnowski (1912: 104) describes as "retentive clay" with deep humus covering the clay.

Originally, the county was chiefly forested with the exception of a few wet prairies in the extreme eastern and western parts. The northwestern townships were on the border of the Black Swamp area and thus characterized by wet lowland forests. Today, the major portion of the county is under cultivation.

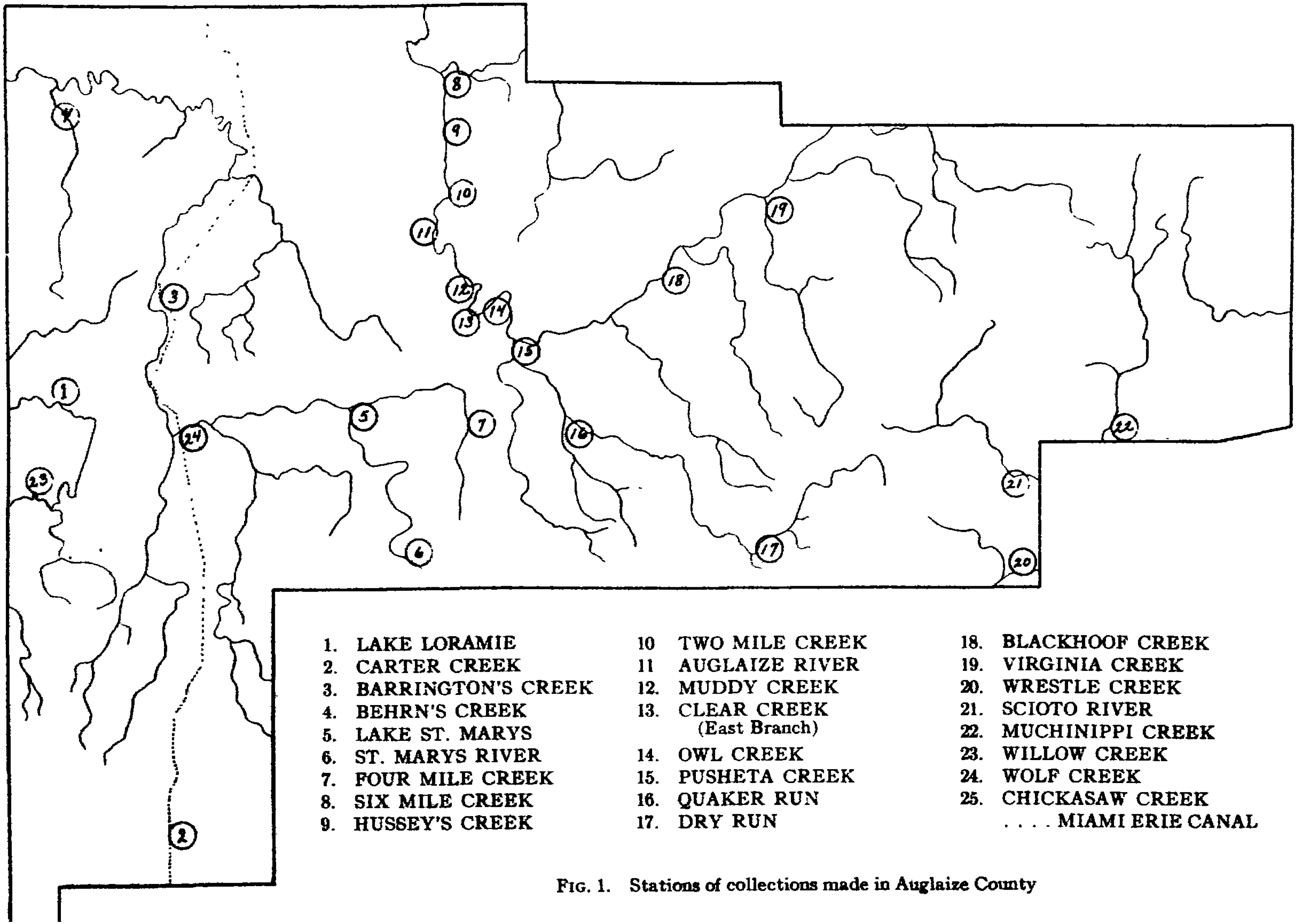


FIG. 1. Stations of collections made in Auglaize County

SOURCES OF AUGLAIZE COUNTY NAIAD FAUNA

Walker (1913: 58) states: " . . . the original pre-glacial fauna of the present St. Lawrence system was absolutely exterminated during the glacial period, and . . . the peculiar fauna now characteristic of Lake Erie is the result of a modification from environmental causes of the postglacial immigrants from the south, and not the result of any survival in that region of any part of the pre-glacial fauna."

Ortmann (1924: 101–117) reviews the theories on the stocking of Lake Erie with naiades and advances his own explanation. His theory postulates a Maumee River which flowed westward through the dry bed of what is now Lake Erie, and connected with the Wabash River. Later, with the closing of the Trent and Nipissing outlet stages, the waters flowed into the Lake Erie basin, "drowning the lower parts of the Maumee River and its tributaries, which then became tributaries to Lake Erie." Carrying these postulates farther, van der Schalie (1933: 11) states that the fauna in the flooded basin either died out or became modified to produce those forms which are recognized as lake forms of the earlier river types. Thus, we may say that the St. Marys and Auglaize Rivers received their original faunas as migrants up the Greater Maumee of Ortmann and into these tributary streams.

"The Wabash and Erie Canal," according to Clark and Wilson (1912: 7), "became a channel of communication which during its half century of existence must have resulted in the exchange of many species of mussels." The Miami and Erie Canal must have acted in a similar way for mussel migration from the Auglaize River through the canal into Lake St. Marys and into the Wabash River. Goodrich (1914: 132) states: "There is excellent reason for believing that the Unione fauna of the Maumee has received additions, by means of this canal [Wabash and Erie], since the days when the upper part of what is now the Maumee water course served as a southward flowing outlet for the glacial Lake Maumee."

Clark and Wilson (1912: 4–5) elaborate on this confluence: "Even at present day the headwaters of the Little Wabash River approach within three miles of the St. Marys and still nearer to small affluents of that stream. . . . There is no perceptible divide between the two basins, and a large open country ditch still unites them through an old flat lake plain known locally as the 'prairie.' A careful examination of this ditch revealed no mussels at all, and it is not likely they could live in the mucky bottom, though it is possible that glochidia might be carried through the stream by migrating fishes." Finally Ortman (1924: 114–115) states, "There is, indeed, the possibility, that in other rivers in the state of Ohio some faunal elements of the upper Ohio drainage may have reached the lake-tributaries by stream-piracy in the region of the headwaters."

According to Goodrich (1914: 131–132) flood waters from the St. Marys River spread across "the prairies" mentioned above by Clark and Wilson, connecting the Wabash and St. Marys River systems during the great flood of March-April, 1913. He also states: "The Naiades of the Maumee and the upper parts of the Wabash now very nearly approximate one another, counting the recent additions for which the Wabash and Erie canal may be thanked."

The Ohio tributaries in Auglaize County have continuously been open to migrations of naiades from the Ohio and Mississippi Rivers.

DRAINAGE SYSTEMS OF AUGLAIZE COUNTY

1. Auglaize River: The Auglaize River is the largest drainage system in the county. Its upper portion in Auglaize County is now dredged and has a fine sand bottom, with only a few inches of water. The remainder is a series of pools and riffles with gravel and rubble bottom, and bordered with water willow (*Dianthera americana*) and lizard's tail (*Saururus cernuus*). The stream is characterized by

broad shallow pools of less than 6 feet of water and a gradient of about 4 feet per mile throughout the county.

2. St. Marys River: The St Marys River above the city of St. Marys is composed of a group of small, clear and shallow tributaries with sand and silt bottoms, and a gradient from 8 to 10 feet per mile. The river below the city is a comparatively shallow sluggish stream, with gravel and deep silt substrata, and less than 3 feet fall per mile

3. Muchinippi Creek: This creek is a tributary of Wolf Creek belonging to the Great Miami River system. It arises in the prairies of eastern Auglaize County and flows southward. The upper portion, because of dredging, is a straight, mud-bottom ditch Near the Shelby County line, it takes on the appearance of a creek with relatively clear pools and sand and gravel riffles.

4. Wolf Creek: Only a short stretch of this creek, now dredged and ditch-like, has a sand bottom and a permenent flow of water. It is very shallow and narrow in this county.

5. Lake St. Marys: This is an artificial body of water formed by impounding tributaries of the St. Marys and Wabash Rivers and flooding the prairie divide. It occupies an area of 15,700 acres with less than 10 feet of turbid water over a bottom composed chiefly of blue-gray silt containing some sand and gravel. The south shore is made irregular by the dense mass of emergent vegetation, chiefly cattails (*Typha angustifolia* and *latifolia*). The north shore is more regular with little vegetation and much more affected by heavy wave action.

6. Miami-Erie Canal: The water levels in the canal are maintained by a series of dams and abandoned locks. A series of wide-waters of which 40 Acre Pond is the largest are included in this area. In general, the canal depth is less than 6 feet with the exception of a two mile stretch below New Bremen where dredging has produced 8 feet of water. A deep silt bottom characterizes the canal proper, but sandy-clay shore lines occur along the wide-waters.

7. Lake Loramie: The upper part of the Minster Branch of Lake Loramie is in Auglaize County, but is not discussed because no naiades were taken there.

ANNOTATED LIST OF SPECIES

Quadrula quadrula (Rafinesque)

This species is found in both the Lake Erie and Ohio drainages according to Sterki (1907: 390). It was taken in the Maumee River in Defiance County by Clark and Wilson (1912: 41). Ortmann (1919: 42), speaking of this species, remarks: "In western Ohio it is widely distributed. Here it crosses over into the Lake Erie-drainage (Ohio Canal, Sterki) and into the lake (Sterki and Walker, 1913)." It is locally common and found partly buried in the sand of wave swept areas of Lake St. Marys. It is probably the most abundant naiad inhabiting the lake. One specimen was taken in the canal at station 24.

Amblema costata (Rafinesque)

Sterki (1907: 390) lists this mussel as generally common in both the Ohio and Lake Erie drainages. Clark and Wilson (1912: 42) state that it is the second most abundant species of mussel in the Maumee Basin and quite abundant in the Auglaize River in Defiance County. Ortmann (1919: 30) reports it from the St. Marys River in Mercer County. In Auglaize County, I have found this naiad in only the Auglaize River, where it ranks as one of the most abundant species. Due to dredging in the upper reaches of the river, large beds of this species have been destroyed and its present distribution is chiefly confined to that portion of the stream below Wapakoneta. Specimens were secured at stations 8, 9, 11, 12, 13, 14 and 18, and were especially common at 13, 14 and 18. In general, this species was found in the more quiet pool-like areas with two to four feet of turbid water over a sandy-silt bottom.

Elliptio dilatatus (Rafinesque)

Sterki (1907: 392) records this naiad as found throughout the state. Clark and Wilson (1912: 14) report it fairly common in the Maumee and common in the Auglaize River. I have only a single specimen taken at station 11 in the Auglaize River.

Fusconaia flava (Rafinesque)

Both Sterki (1907: 392) and Clark and Wilson (1912: 39) list this species as a widely distributed naiad. Clark and Wilson state: "It is fairly common all along the Maumee and its tributaries." This species is represented in the St Marys, Auglaize and Great Miami drainages (stations 10, 13, 14, 18, and 20), although nowhere found in abundance Ortmann (1919: 30) reports it from the St. Marys River in Mercer County. This naiad is usually found in shallow water over firm sand with either winding trails or only the exposed siphons of the buried mollusk to indicate its presence

Pleurobema cordatum coccineum (Conrad)

A state-wide distribution of this species is claimed for it by Sterki (1907: 392). However, Clark and Wilson (1912: 39) took only 31 specimens in the Maumee drainage. I found it at only two stations, 18 and 12, in Auglaize County. At the latter station, a dozen specimens were taken from the fine gravel bottom covered by less than 18 inches of water

Anodonta grandis Say

Sterki (1907 394) lists this species as state wide in distribution, but Clark and Wilson (1912: 46) found only occasional specimens in the rivers which they investigated Ten specimens were taken by them from the Auglaize River in Defiance County Ortmann (1919: 144) reports specimens collected by Goodrich from the St. Marys in Mercer County. I found *A. grandis* to be the most abundant naiad in Auglaize County It was taken at stations 3, 4, 7, 8, 10, 11, 12, 14, 15, 18, 19, 22, 23 and 24.

This species abounds in sluggish pools with deep soft silt bottoms. The thinner shelled specimens are often found resting on top of the mud while heavier shelled forms may be buried in the riffles.

A great deal of variation in this species is noted by Sterki (1907: 394) and van der Schalie (1938: 51). The latter states, "We do not have sufficient ecological and life-history data to enable us to solve the systematic difficulties which arise from this group. For instance, specimens occurring in lakes tend to be more inflated anteriorly and in the region of the beaks and usually have a finer beak sculpture than those found in rivers. But there are all kinds of intergrades. . . . "

Anodonta imbecillis Say

This interesting species was recorded by Sterki (1907: 395) as, "Over the state, common, in all kinds of waters." Clark and Wilson (1912: 47) found one specimen in the St Marys River at Ft. Wayne and 38 in the canal at Maumee, Ohio. Ortmann (1919: 164) reports specimens taken by Goodrich in the Miami-Erie Canal in Lucas County, Ohio. This mussel was taken at stations 23, 24, and 19. Its abundance in the dredged channels of Lake St. Marys is indicated by the numerous specimens taken while deepening the channel. The habitats from which my specimens were taken seem to indicate that it prefers soft sand or silt bottom conditions in quiet water areas.

Lasmigona compressa (Lea)

Sterki (1907: 393) attributes to it a state wide distribution, but Clark and Wilson (1912: 46) found only one specimen in their Maumee River work. During this study, one specimen was taken in the Auglaize River at station 11 and five specimens in Wolf Creek at station 20.

Lasmigona costata (Rafinesque)

A state wide distribution for this species is given by Sterki (1907: 393). It was found to be a common species in both the Maumee and Auglaize Rivers by Clark and Wilson (1912: 45–46).

Goodrich also collected it in the Maumee River in Defiance County and in the St. Marys in Mercer County (Ortmann 1919: 128). It was found in Auglaize County at stations 8, 10, 12, 13, 14 and 18 in the Auglaize River proper.

Ortmann (1919: 30) states: "It is found in large rivers as well as in small creeks, although it is distinctly more abundant in the latter. There is hardly any small stream from which it is entirely absent. . . . " As suggested by van der Schalie (1938: 54), I found this statement only partly true. This naiad is distributed throughout the lower Auglaize River in this County, but it does not occur in the upper part or in the larger tributaries. I found the majority of my specimens in shallow, sand and gravel riffles with noticeable current as did Price (1940: 13) in Franklin County, Ohio.

Anodontoides ferussacianus (Lea)

A widespread distribution over the state is claimed for this species by Sterki (1907: 394). However, Clark and Wilson (1912: 46) found no specimens in the Maumee drainage of Ohio. I find this naiad to be widespread over the county in practically all water areas, stations 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 18, 19, 20, 22, and 23. It is especially common at stations 7 and 20, both in small headwater streams. It ranks next to *Anodonta grandis* as the most abundant naiad in Auglaize County. This mussel was most abundant in the more quiet stretches of shallow water living partly buried in the sandy silt.

Two top minnows (*Fundulus notatus*) and one green sunfish (*Lepomis cyanellus*) collected at station 6 in Muddy Creek carried glochidia between the rays of the caudal, dorsal and anal fins. *Anodontoides ferussacianus* was the only species of naiad taken in this creek, and I therefore supposed that the glochidia were of this species.

Strophitus rugosus (Swainson)

This mussel is recorded as widespread over the state, as common and variable by Sterki (1907: 394). But, Clark and Wilson (1912: 47) state that it: " . . . is not common in the Maumee Basin . . . none were seen in the Auglaize River." Goodrich collected it in the St. Marys River in Mercer County (see Ortmann, 1919: 203). It was not found to be common at any location in this county but was taken at stations 7, 11, 12, 13, 17, and 18. This naiad is found most commonly in creeks and small streams with sand, silt, or fine gravel bottoms.

Alasmidonta calceolus (Lea)

A. calceolus is common throughout the state according to Sterki (1907: 393). Clark and Wilson (1912) do not mention this species in their report on "The Mussel Fauna of the Maumee River." During this study, it was found in the Great Miami and Auglaize River systems at stations 15, 16, 17, 19, 21, and 22. It was abundant in Pusheta Creek at station 15, and common at stations 19 in Blackhoof and 22 in Muchinippi Creeks. This species was found only in the smaller creeks where it was usually buried in the sand and gravel on the bars and riffles.

Alasmidonta marginata (Say)

According to Sterki (1907: 393), it is found over the state in both the Ohio and Lake Erie drainages. Ortmann (1919: 185) lists it from the Maumee River in Defiance County, but it was not mentioned by Clark and Wilson (1912). During four years of collecting in Auglaize County, I have taken one specimen. This was collected at station 13 in the Auglaize River. The ecology of this species is given by van der Schalie (1938: 61) as follows: "In the small-river areas of the upper part of this drainage [Huron River] it occurs on a sand and gravel bottom in current."

Ptychobranchus fasciolare (Rafinesque)

This species occurs in both drainages in Ohio according to Sterki (1907: 390), but was not abundant anywhere in the Maumee Basin according to Clark and Wilson (1912: 48). Goodrich also collected it in the Maumee River in Defiance County (Ortmann, 1919: 211). I have only two specimens from Auglaize County, both from the Auglaize River and taken approximately one mile apart. Henry van der Schalie (1938: 61) states it, " . . . is usually found buried deep in an unshifting sand and gravel bottom in rapids and seems to show definite aversion toward ponded or backwater conditions."

Micromya iris (Lea)

Sterki (1907: 389) lists this species as occurring in both drainages and Clark and Wilson (1912: 51) claim it does not appear to be common in the Maumee Basin but is probably more common than collections would indicate. Only five specimens were taken in the county, one at station 12 and four at station 18, all in the Auglaize River proper. In every instance specimens were taken in sand deposits on the downstream side of large patches of water willow in shallow water.

Carunculina parva (Barnes)

According to Sterki (1907: 389) this mollusk is found, " . . . over the state (both drainages, Lake Erie); rivers, creeks, and canals." My records show this species as common at station 4 in Hussey's Creek, but rare at stations 3, 7, 15 and 18. This mussel has been collected frequently in Lake St. Marys in Mercer County, but as yet I have found none in the Auglaize County end of the lake. All collections were taken from fine sand silt and clay in shallow waters.

Lampsilis fasciola Rafinesque

Sterki (1907: 388) gave as its distribution, "both drainages, over the state." Clark and Wilson (1912: 54) state: "This very attractive little mussel was not common in the Maumee Basin. . . . " Goodrich collected it in the Maumee River in Defiance County (Ortmann, 1919: 311). My one specimen from this county was found at station 13 in the Auglaize River. Ortmann (1919: 311) describes its habitat as follows: "In Pennsylvania it distinctly prefers riffles with lively currents and gravelly bottoms, but it is not found in very strong currents and among large rocks."

Lampsilis siliquoidea (Barnes)

The distribution as given by Sterki (1907: 388) is "Over the state, common and variable; common in Lake Erie and decidedly variable. . . . " Clark and Wilson (1912: 52–53) indicate its widespread distribution in the Maumee Basin, and Goodrich (Ortmann, 1919: 286) collected it in the St. Marys River in Mercer County. It was taken at stations 7, 8, 10, 12, 13, 14, 15, 18, 20, and 21 in the Great Miami, Auglaize and St. Marys river drainages. It is locally very abundant and would probably rate as third in abundance in the county.

Like Ortmann (1919: 288), I found it prefers rather quiet water and sandy-mud bottom conditions. Much variation in specimens is noted. Ortmann (1919: 291), concerning the subspecies *rosacea*, remarks: "I have the impression that *rosacea* is not so much a geographical, as an ecological race, produced by the environment of great lakes, and that it turns up wherever the proper conditions are offered." Variation in this species is shown in relation to exposure by Brown, Clark and Gleissner (1938, Fig. 3). The same authors state (1938: 699), "The differences found between individuals of the same species from streams and lakes does not seem so singular when series from a large number of habitats within lakes and streams are compared. Such a series certainly shows complete intergradation for the shell characters of size and shape. A suitable stream habitat favors the large sizes and the exposed large lake habitat, the extreme cases of stunting."

Lampsilis ovata ventricosa (Barnes)

Sterki (1907: 388) states that *L. ventricosa* occurs over the state, is very variable, and is also common in Lake Erie. He states further that *L. ovata* occurs in the Ohio and Greater Miami Rivers. Clark and Wilson (1912: 54) state that *L. ventricosa*, in some localities, runs into a species which in its form is known as *L. ovatus* but, "in the Maumee Basin it is well marked and fairly uniform." Ortmann (1919: 304–305) lists northwestern Ohio specimens as *L. ovata ventricosa* and gives the following specific records: the Maumee River in Lucas and Defiance Counties; Beaver Creek in Williams County; and the Scioto River in Hardin County. He (1919: 303) states that both *L. ventricosa* and *L. ovata ventricosa* are, "forms of the same species connected by numerous intergrades, but locally may be pure." The Specimens of Auglaize County can well be placed as intergrades from a transition zone. The difficulties in the systematics of these forms are discussed by Ortmann (1919: 298) and they will not be discussed here. Only five specimens were collected in the county at stations 12, 13, 15 and 18. These were taken in pool-like areas on the downstream side of beds of water willow in deposits of soft sand and silt. These data agree with Ortmann's observations (1919: 306).

Uniomerus tetralasmus Ortmann

The variety *U. tetralasmus camptodon* (Say) is recorded from the Great Miami River by Sterki (1907: 392) and was taken in Lake St. Marys in Mercer County. It is locally very abundant in the Miami-Erie Canal. Many shells are cast upon the beaches of Lake St. Marys by the wave action but no living specimens have been taken from the lake during my collecting. From the shells on the beaches, we may assume it to be fairly common in the lake.

	St. Marys River	Hussey's Creek	Barrington's Creek	Clear Creek	Carter Creek	Muddy Creek	Auglaize River	Two Mile Creek	Pusheta Creek	Owl Creek	Quaker Run	Dry Run	Blackhoof Creek	Virginia Creek	Wrestle Creek	Muchinippi Creek	Willow Creek	Wolf Creek	Miami-Erie Canal	Lake St. Marys	Behm's Creek	Lake Loramie
Quadrula quadrula							x													x		
Amblema costata							x															
Elliptio dilatatus							x															
Fusconaia flava							x											x				
Pleurobema cordatum coccineum							x															
Anodonta grandis		x		x			x	x	x				x			x		x	x			
Anodonta imbecillus							x						x			x		x				
Lasmigona compressa							x											x				
Lasmigona costata							x															
Anodontoides ferussacianus		x		x		x	x	x	x				x			x		x				
Strophitus rugosus				x			x		x													
Alasmidonta calceolus									x				x			x	x					
Alasmidonta marginata							x															
Ptychobranchus fasciolare							x															
Micromya iris							x															
Carunculina parva		x		x			x		x										x			
Lampsilis fasciolare							x															
Lampsilis siliquoidea				x			x		x								x	x				
Lampsilis ovata ventricosa							x		x													
Uniomerus tetralasmus																			x	x		

FIG. 2. Distribution of species in the water areas of Auglaize County.

FUTURE OF AUGLAIZE COUNTY NAIADES

Numerous factors combine to limit the abundance of mussels in any body of water. The influences of civilization are proving detrimental to the fauna of this county. The most serious limiting factor is that of erosion silt. Ellis (1931: 5) states, "The outstanding factor producing changes in river conditions at present throughout the Mississippi River system was found to be erosion silt." Dredging in the headwaters of the Auglaize River in 1940 (Clark 1942: 10), " . . . resulted in placing such quantities of silt in suspension as to form the chief sources of pollution in the river. This silt was deposited approximately 4 miles downstream, covering the gravel and rubble bottom to a maximum depth of 4 inches." The filling in of backwater areas and the increasing turbidity of Lake St. Marys are of concern to all who are interested in this lake. Ellis (1931: 6–7) indicates that the heavy silt loads of streams create unstable bottom conditions, cover mussel beds and juvenile mussels and, " . . . affects the mussel survival of both young and adults through the oxygen supply." The suitability of the soil of Auglaize County for tillage, the removal of existing timber, and increasing demands on agriculture will without doubt result in more dredging, ditching and tiling, thus increasing the silt load of our streams.

The small size of most of Auglaize County streams implies an irregularity of flow which possibly ranks with erosion silt as one of the most limiting factors of a large naiad population. The Auglaize and St. Marys Rivers, Blackhoof, Pusheta, Muddy, Clear, Muchinippi and Wolf Creeks are permanent streams, (note naiad distribution in Fig. 2) but the remaining ones become intermittent during the dry seasons. All streams of this county were once spring fed and the increasing irregularity in stream flow indicates the disappearance of these springs. As early as 1907, Sterki (1907: 368) mentioned this factor as one of those responsible for the disappearance of mollusca.

The problem of pollution is one of importance in the St. Marys River below the city of St. Marys and in the Auglaize River below Wapakoneta. Deposits of sludge are common in both causing the elimination of the naiades.

The changes in the ecological factors of the streams through irregularity of stream flow, pollution, and increasing silt loads have resulted in increased turbidity, decreased amounts of vegetation, changes in the substratum and a corresponding change in fish life or hosts for the parasitic stages of naiades. A comparison of reports by Clark (1942: 1–171) and Kirsch (1894: 334–337) show that Kirsch obtained 14 species of fish not found at present in the upper portion of the St. Marys River. This means a loss of 14 potential hosts of the parasitic naiad stages.

The impounding of streams and the subsequent silting over of mussel beds (Ellis 1931: 8) has not become a serious problem in this county. One dam in the Auglaize River at Wapakoneta impounds possibly a mile of the stream This dam may impede the upstream migration of fish and thereby reduce the number of hosts for the parasitic mussel glochidia.

Sterki (1907: 368) states, "The canals, which were great routes for mollusca, are more and more neglected, and partly abandoned." The Miami-Erie Canal with its chain of small ponds is intact throughout Auglaize County, but abandoned in Shelby County to the south and Allen County to the north. Portions of the canal are held at their original levels by a series of dams and locks, but the deep soft mud banks and the limited number of species of fish do not provide attractive conditions for a heterogeneous mollusca population.

The collecting of mussels for pearls or for the button industry has not affected the population of this county. I have never seen or heard of a pearl or button shell collector in this county and doubt if one will work these streams because the naiad population is too small to induce such activities.

We have a fair muskrat population in this county but as yet I have not found one of the "kitchen middens." In the adjacent county, Logan, I have counted as many as 195 pairs of shells of *Anodonta grandis*, *Quadrula quadrula*, and *Carunculina parva* at one of these feeding sites at Indian Lake. H. van der Schalie (1938: 75), states that, " . . . the muskrat and mink are most destructive to them [naiades] in the river and lakes above Ann Arbor.

SUMMARY AND CONCLUSIONS

1. The naiad fauna of Auglaize has been found to consist of 19 species.
2. A new host is reported for the glochidia of *Anodontoides ferussacianus*.
3. The naiad fauna of Auglaize County is a composite of several potential routes. Perhaps the most significant is the "Greater Maumee River" as postulated by Ortmann and the Ohio Canal system. Other possible sources are in the form of an exchange of species through later connections of the St. Marys and Wabash River by means of dicthes and floodwaters. Furthermore there is a possibility of stream piracy among all headwater streams bringing about an open route to the Ohio River through its tributaries.

4. The distribution and abundance of naiades in Auglaize County is determined in part by ecological and habitat conditions.

5. Drastic changes in the ecology of the aqautic conditions in this county have without doubt resulted in the reduction or extermination of some species, an increase of others, and perhaps an addition of new inhabitants.

6. Erosion silt and the increasing irregularity of stream flow are the most detrimental factors to our mussel fauna.

7. Those species which are tolerant of the most widely diversified conditions are the most abundant in Auglaize County.

8. The mud-inhabiting species or those most tolerant of highly turbid waters are the ones which will probably continue to increase under existing conditions.

9. The mussels of Auglaize County have little economic importance and no mussel fishery can be anticipated.

BIBLIOGRAPHY

1. **Brown, C. J. D., Clark, Clarence,** and **Gleissner, Bruce.** 1938. The Size of Certain Naiades from Western Lake Erie in Relation to Shoal Exposure. Amer. Mid. Nat. 19: 682-701.
2. **Clark, Clarence F.** 1942. The Fishes of Auglaize County. M.Sc. Thesis, Ohio State Univ.
3. **Clark, H. Walton,** and **Wilson, Charles B.** 1912. The Mussel Fauna of the Maumee River. U. S. Bur. Fish. Doc. 757: 1-72.
4. **Dachnowski, Alfred.** 1912. Peat Deposits of Ohio, Their Origin, Formation and Uses. Geol. Surv. of Ohio, Bull. 16.
5. **Ellis, M. M.** 1931. Some Factors Affecting the Replacement of the Commercial Fresh-water Mussels. U. S. Bur. Fish. Fisheries Circ. 7: 1-10.
6. **Goodrich, Calvin.** 1914. Unione Fauna of the Wabash and Maumee Drainage Systems. Naut. 37: 131-132.
7. **Hobbs, William Herbert.** 1921. Earth Features and Their Meaning. McMillan & Co.
8. **Kirsch, Philip H.** 1895. Report on Investigations in the Maumee River Basin During the Summer of 1893. U. S. Fish. Comm. 14 (1894): 315-337.
9. **Leverett, Frank.** 1902. Geological Formations and Drainage Features of the Erie and Ohio Basins. U. S. Geol. Surv.
10. **Ortmann, Arnold E.** 1919. A Monograph of the Naiades of Pennsylvania. Part III. Mem. Carn. Mus. 8, 1-384.
11. **Price, Afton Ellmore.** 1940. A Check List of the Naiades of the Streams of Franklin County, Ohio. M.A. Thesis, Ohio State Univ.
12. **Sterki, V.** 1907. A Preliminary Catalogue of the Mollusca of Ohio. Proc. Ohio Acad. Sci. 4, 8: 367-402.
13. **van der Schalie, Henry.** 1938. The Naiad Fauna of the Huron River, in Southeastern Michigan. Misc. Pub. Mus. Zool. Univ. Mich. 40: 1-83.
14. **Walker, Bryant.** 1918. The Unione Fauna of the Great Lakes. Naut. 27: 56-59.
15. **Winchell, N. H.** 1894. Report on the Geology of Auglaize County. Rept. of Ohio Geol. Surv. 3: 404-409.

PRELIMINARY ANNOUNCEMENT

SYMPOSIUM ON PREMEDICAL EDUCATION

A. A. A. S. Meeting, Cleveland, Ohio

Alpha Epsilon Delta, national honorary pre-medical fraternity, is arranging a special program on Premedical Education to be held on Thursday, September 14th, during the A. A. A. S. meeting in Cleveland. The influence of the war and the accelerated training program upon postwar plans for premedical education will be among the major topics for discussion.

Dr. Victor Johnson, Secretary, the Council on Medical Education and Hospital of the American Medical Association; Dr. Carlos Reed, professor of physiology, University of Illinois, and Dr. H. E. Setterfield, premedical adviser, School of Medicine, Ohio State University, and president of Alpha Epsilon Delta, will be among the distinguished speakers. An informal round table discussion of problems and questions from the audience will follow the talks. All premedical teachers, especially those in colleges not associated with medical schools, are urged to attend. It is hoped that many teachers in non-science fields will attend also. Final announcement of the time and place will appear in the program of the meeting.

STUDIES IN THE BIOLOGY OF THE LEECH.[1] VIII.

MODIFICATIONS IN NEUROLOGICAL MICROTECHNIQUE

JOHN A. MILLER,
Department of Zoology and Entomology,
Ohio State University

During the last two decades of the nineteenth century there were devised several basic methods of neurological microtechnique.[2] These made possible the study of the minute structure of the nervous system. Many modifications of these and other techniques have been offered until, at the present, there are probably more variations in neurological methods than in any other. This multitude of divergent procedure is based upon necessity.

In the study of nervous tissue there are many variable factors which influence to a marked degree the cytological as well as histological results. A few of the better known variables are functional condition, structural differentiation, and age of the tissue. The taxonomic position of the organism must be considered, and in many instances, species variation taken into account. In addition, there are many imperfectly known factors demanding variations in procedure that can be determined only after extensive experimentation.

The methods designed to assist in the microscopical examination of the nervous system can be divided into two fundamental groups: the one spoken of as cytological, and the other as histological or anatomical. The former refers to those techniques which, by virtue of minute qualitative differentiating properties, make possible a study of the intimate structure of nerve cells, processes, and their supporting tissues. The latter, histological or anatomical, applies more particularly to the minute structure and composition of nervous tissue. In general this latter type of study is concerned with the architectural arrangement of nerve cells, their processes, and their connections with one another.

The interest in chordates, and more particularly in man, has inspired exhaustive research for adequate neurological methods applicable to this group. To a large extent the methods presented for the study in invertebrate nervous systems have been borrowed, and modified from vertebrate procedures. Exceptions to this were the contributions to invertebrate neurological microtechnique made by some of the early investigators, and their students.

Retzius, Cajal, and deCastro, Smallwood, Rogers, Ascoli, Sanchez, to mention only a few, have each presented numerous modifications in neurological methods. Each has contributed to the growing list of variable procedures employed in the demonstration of nerve elements. Each has presented techniques applicable to the particular field of investigation in which he worked. With all due respect to these and other technicians, problems in invertebrate neurological research have remained unanswered for want of adequate cytological and histological methods.

THE PROBLEM

The behavior of an animal is the result of stimuli acting upon a particular arrangement of anatomical structure under the physiological conditions existing at the time of stimulation. The determination of the histological character of the tissue involved is a necessary prerequisite to an analysis of the causal factors in behavior. The leech, *Haemopis marmoratis*, (Say) has been used for some time by the writer in studying various aspects of annelid behavior. With the exception of the description of the subepidermal nerve plexus (1933) the authors' reaction studies have, for the most part, been of an analytical nature. Certain conclusions derived from the study of behavior, have, by inference, implied the general pattern of the nervous system. The limited knowledge of the nervous system of this form is to a large extent due to inadequate cytological and histological methods. The writer employing certain well founded principles of neurological procedure presents the following new methods and modifications.

---

[1] *Haemopis marmoratis* (Say).

[2] *These methods are reviewed in* Lee, McClung *and others.*

NEUROLOGICAL METHODS

The methods used and the results obtained, as set forth in this paper, pertain specifically to the aforementioned animal. These procedures have not been tried on any other form. To what extent these methods may be applicable to other animals is a matter for further investigation. The discussion which follows should be considered with these points in mind.

RELAXING, KILLING, AND FIXING

These three steps in the preparation of the animal, and more particularly, the tissue to be studied, were considered as one operation. But inasmuch as variations were employed in each of the above, they will be presented separately. These were important details, for in many cases the success of the staining process was dependent upon these as well as subsequent treatments. The appearance of the tissue may be entirely altered by deviations from the prescribed methods.

Relaxing was the first step in the preparation of the leech for subsequent study. The three methods which were used are stated below. Each was employed in accordance with the killing and fixing procedure discussed later in this paper.

RELAXING METHODS

Method I. The leech was placed in a shallow glass dish containing a 0.1% to 0.2% solution of chloretone, to which had been added a pinch of proteolitic enzyme. (Caroid was found satisfactory). This latter, while not absolutely necessary, materially aided in disposing of the copious mucous secreted by the organism. After five minutes in the chloretone solution there was added, drop by drop, a saturated solution of the same, until the leech was completely relaxed. Dissection followed, or if the animal was to be imbedded in toto, it was straightened to normal size in a wax bottom dissecting pan, where it was held in position by pins. The first application of the killing and fixing agent was applied at this time.

Method II. Ether was an equally satisfactory relaxing agent. The leech was placed in a covered dish, into which was previously introduced a wad of cotton saturated with ether. In due time the animal was completely relaxed, and treated as stated in No. I.

Method III. This method differed from Method I or II, only in the anesthetic employed. In this method, alcohol was used in place of chloretone. Animals were prepared in this way when an alcoholic fixing medium was employed.

KILLING AND FIXING METHODS

Killing and Fixing procedure will be considered under one heading. While killing is usually referred to as the act of stopping all life processes and fixing a method of preserving the normal cell structure, the two steps should be accomplished simultaneously. Usually a single medium is employed for this purpose. If the nervous system is dissected prior to final fixation, great care should be exercised in the manipulation of the tissue. The same care should be taken if dissection is made following killing and fixing. As will be noted later in this paper, the staining methods employed and the results obtained are dependent to a large extent on this step.

Method I. A solution of 10% formalin was used to kill and fix either the dissected tissue, or the entire organism. The usual time of fixation was 24 hours. If no secondary fixing agent was employed following formalin fixation, washing in tap water for 5 minutes followed by several changes in distilled water was sufficient. If a secondary fixing solution was employed, the material was washed 5 hours or more in running water.

Method II. Bodian's No. 2 fixation was used with good results following either chloretone or alcohol relaxation. Bodian's was made by using 90 cc. of 90 per cent alcohol, plus 4 cc. commercial formalin plus 5 cc. acetic acid. The fixing period was 4 days.

Method III. Zenker's fixative was employed in the Masson technique. The material remained in the Zenker's solution for 10 hours; then washed an equal length of time in running water.

Method IV. Helly's fluid, a modification of Zenker's, in which the acetic acid in the latter was replaced by 5 per cent formalin, and used with Mallory's phosphotungstic acid in combination with hemotoxylin.

DEHYDRATION, CLEARING, INFILTRATION AND EMBEDDING

Dehydration was accomplished with the aid of alcohol alone, or in combination with dioxane. In order to expedite these standardized procedures, the leech was cut into three equal lengths. When the central nervous system had previously been dissected such portions were carried intact through these steps. The above processes may, depending on the procedure followed, precede or follow the basic staining technique.

DEHYDRATION METHODS (PARAFFIN METHOD)

Method I. The gradual removal of water was facilitated by alcohol, proceeding in the usual routine of passing the material through ascending grades. From 100 per cent alcohol the material was passed into a mixture of equal parts of 100 per cent alcohol and zylol. This procedure was employed on mounted sections of small pieces, after the use of an aqueous stain. For mounted sections the time in each of the lower grades of alcohol was 3 minutes; for 100 per cent alcohol and for half alcohol and half xylene the time was 5 minutes each, except where otherwise noted.

Method II. This was one of several procedures followed for dehydration prior to paraffin embedding. The properly killed and fixed specimen, or selected portion, was placed in 70 per cent alcohol for 3 hours. The tissue was then placed for 2 hours each in 83–90–95 per cent alcohol, respectively.

Method III. A third method used to prepare material for paraffin infiltration was as follows: The specimen, or part thereof, was placed in 70 per cent alcohol for 3 hours. Two changes were made in this grade. The tissue was then transferred to 100 per cent dioxane for 3 hours.

DEHYDRATION METHOD (CELLOIDIN)

Method IV. In the dehydration of material for celloidin embedding, it was necessary to insure absolute removal of all water. The following procedure proved to be adequate for parts of the nervous system, or sections of the animal. Beginning with 30 per cent alcohol, the material was carried through 50–70–80–95–100 per cent for a minimum of 2 hours each. Two changes of 2 hours each in absolute alcohol-ether completed this step.

CLEARING METHODS

Clearing is the process of removing the alcohol from the section or specimen and the substitution of a fluid miscible with paraffin. In this step the tissue becomes translucent. Variations in method and material used in this step were dependent upon the nature of the tissue, and their place in the operation as a whole.

In preparing a specimen for infiltration and embedding in paraffin, the first two methods given below were satisfactory. It is my observation that for *H. marmoratis*, method II gives less hardening with a minimum of shrinkage.

Method I. Immediately following dehydration, the specimen was placed in a mixture of one-half butyl alcohol and one-half soft (48°) paraffin. The specimen remained in this mixture over night in a closed dish in an oven of 58° C. At the end of 12 to 14 hours, the specimen was ready for further infiltration. This method was employed after dehydration method III.

Method II. Dehydration by method II was followed by placing the specimen in a mixture of one-half chloroform and one-half soft paraffin. In this medium, the specimen was allowed to remain over night in a closed dish at room temperature. Further infiltration followed the regular procedure outlined below.

Method III. In the clearing of mounted sections following dehydration carbol xylene or xylene was used. The usual procedure of employing at least two changes of xylene was followed.

Method IV. Sections previously embedded in celloidin were cleared in cedar wood oil before mounting.

INFILTRATION AND EMBEDDING

Infiltration is the process of replacing the clearing agent with the material in which the tissue is to be imbedded. It also refers to the gradual impregnation of the tissue by celloidin, in instances where this latter is employed as the supporting medium. This step was accomplished by gradually infiltrating the tissue building up to the required density or concentration of the supporting agent.

Paraffin Method (Infiltration). Following clearing methods I or II, the material was placed in soft paraffin for two hours. This was replaced by a mixture of half soft and half hard (58°) paraffin and returned to the oven for two hours. The same procedure was repeated using hard paraffin. If used paraffin was employed, it was followed by an addition change of two hours in fresh paraffin. The hard paraffin, being the so-called "rubber paraffin," had a melting point of 56°–58° C. This same grade was used in the embedding process.

Paraffin Method (Embedding). This is a process in which the tissue or specimen is enclosed in a hardened block of supporting medium. Paraffin and celloidin are the conventional agents employed. Following the infiltration process, embedding is the final step prior to sectioning. In this step, as in all others, practice and repeated trials prove to be the best guide.

Plaster of Paris boxes were the most satisfactory embedding forms used for the paraffin method. Plaster of Paris boxes were soaked in water a few minutes prior to the introduction of the paraffin. The specimen was transferred from the infiltrating medium by warmed forceps, oriented, imbedding paraffin added, and a label inserted. As soon as a film forms over the surface of the paraffin the entire preparation was immersed in ice water, the contraction of the paraffin freeing the block. Many specimens can be so embedded in a short time, using not more than two plaster of Paris boxes in rotation.

Celloidin Method (Infiltration and Embedding). Material to be infiltrated and embedded in celloidin was dehydrated according to method IV. Following dehydration, the tissue was placed in 10 per cent celloidin for eight hours, then left over night in 15 per cent celloidin. The material to be mounted was supported by a block of hardened celloidin, and oriented within a mould formed by surrounding the fiber cutting block with gummed paper. The cutting block mould was then filled with 15 per cent celloidin; the tissue oriented and hardened under a bell jar. Chloroform was used to complete the hardening. After a few hours the block was placed in thin cedar wood oil, where it remained until sectioned. It must be kept in mind for the above outlined procedure that the block of tissue was small.

The celloidin method of infiltration and embedding was the most satisfactory procedure where thick sections were desired. The celloidin method is particularly suitable for large tissue masses, but, in such instances infiltration and embedding may take days, or even weeks. It is essential that the tissue be infiltrated *gradually* and hardened slowly. Cedar wood oil was used in preference to alcohol during the cutting process. Sections were then cleared in thin cedar wood oil until further treatment.

STAINING METHODS

As previously stated, the writer was interested principally in behavior studies involving the neuro-anatomy of the leech. The application of neurological methods served only as a means toward the proposed objective. With all of the facilities of the Department of Anatomy of the Ohio State University at the writer's disposal, the initial project was begun. With the encouragement of the teaching staff and the able counsel of the Department's technician, many previously described methods were tried, none of which gave the desired results. It must not be inferred from this that the following tried and proven techniques failed entirely. On the contrary, thousands of sections proved extremely interesting. But in none of these, using the following basic procedures, were the desired elements sufficiently differentiated. The following are a few of the basic procedures first tried and later modified.

1. Activated protargol, D. Bodian.
2. Modified protargol, D. Bodian.
3. Formol thionin.
4. Methods I, II, III, and IV, (S. R. Cajal and deCastrol), Micro. Tech., McClung, 1937.
5. Iron hematoxylin.
6. Kopsch Golgi method.
7. N. C. Foot's modified Bielschowsky.
8. Ammoniated silver modification of J. W. Kernohan.
9. Masson technique.
10. Mallory's phosphotungstic acid and hematoxylin technique.
11. Ranson's pyridine silver method.

MILLER'S METHOD

The outlined procedure which follows was presented in detail by Miller (1944). This method combines several basic principles of neurological technique. Although it is a lengthy procedure it gives excellent differentiation to leech material. Sections prepared by this method are useful in both histological or cytological study.

The following outline denotes each step in the procedure:

1. Animal relaxed according to method I.
2. Killed and fixed as described in method I.
3. Nervous system dissected. A ventral strip of body wall may be left attached for convenience in orientation. A completely dissected nerve trunk was pinned on a strip of heavy paper bent to form a bow.
4. Tissue immersed in 5% potassium dichromate two weeks.
5. Rinsed in several changes of distilled water.
6. Tissue placed in 1% solution of silver nitrate; after precipitate forms, transfer to fresh 1% solution silver nitrate for one week.
7. Rinsed in several changes of distilled water.
8. Dehydrated, infiltrated and embedded as directed in preparation of celloidin sections.

9. Sections cut to desired thickness.
10. Sections transferred to thin cedar wood oil. This may be left here until clear, or until ready to proceed. Sections can be kept serially by separators.

At this point, two alternative procedures were followed—(A or B).

11A. Sections gradually hydrated and placed in
12A. Six per cent silver nitrate solution for four days (in dark).
13A. Washed in several changes of distilled water.
14A. Reduced for 24 hours in the following mixture (in dark):

Hydroquinone. .	2.0 g.
Neutral formalin.	20.0 cc.
Water (distilled)	200.0 cc.

15A. Washed in several changes of distilled water.
16A. (Optional) Tone in 0.2% gold chloride, 30 minutes.
17A. Washed in distilled water.
18A. Fixed in 5% hypo-sulphite of soda, 30 seconds.
19A. Washed in distilled water. (Counter stain at this point if desired.)
20A. Dehydrated, cleared, mounted in clarite.

OPTIONAL PROCEDURE:

11B. Sections from cedar wood oil were gradually hydrated then placed in
12B. 20% silver nitrate solution, 1 hour to 1½ hours.
13B. Washed quickly in distilled water and placed in
14B. Ammoniated silver nitrate, 3 minutes. This was prepared by adding concentrated aqua ammonia drop by drop to 20% silver nitrate solution until ppt. is almost dissolved and then filtered. This must be freshly prepared, and can be used but once
15B. Washed quickly in distilled water.
16B. Sections placed in 10% formalin 1 minute.
17B. Washed in several changes of distilled water.
18B Tone in 2.0% gold chloride, 10 minutes.
19B. Washed in distilled water.
20B. Optional procedure: Reduce in 2.0% oxalic acid plus 1 cc. formalin per 100 cc. of solution, 20 seconds
21B Washed in distilled water.
22B Fixed in 5% hypo-sulphite of soda, 2 minutes.
23B. Washed in distilled water (counter stain at this point if desired).
24B. Dehydrated, cleared, mounted in clarite.

A counter stain was used successfully following either of the above variations. Mayer's acid hematoxylin and eosin, or Mayer's haemalum gave good cellular differentiation. Mallory's phosphotungstic acid hematoxylin as a counter stain was very effective following either of the above variations. Standard procedures were followed for counter staining and subsequent treatment.

Method A produced the best material for histological study, particularly with reference to the longitudinal and frontal sections. Method B was especially useful in cytological study, being particularly valuable in sections through ganglia. Both variations were equally satisfactory for general morphological studies.

OTHER METHODS

In the course of this study many different techniques were employed. There were several which gave good supplementary results. In most instances, modifications from established procedures were necessary in adapting the technique to leech material. At this point the writer wishes to emphasize the importance of

---

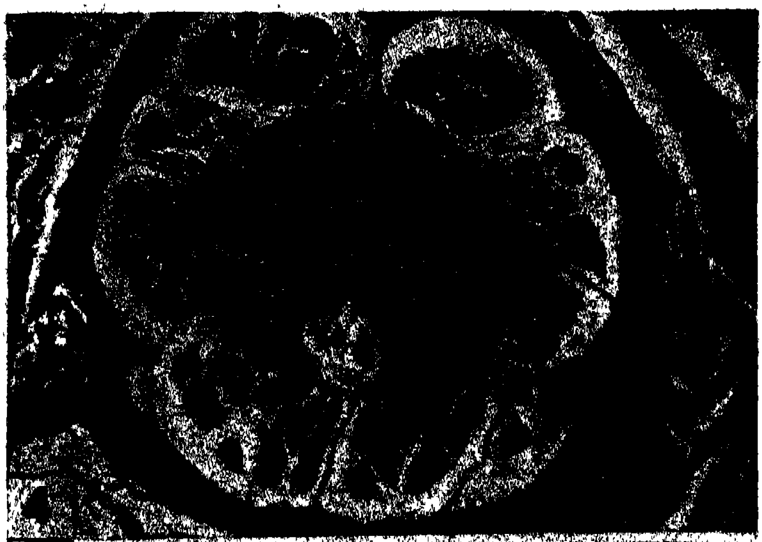
EXPLANATION OF PLATE I

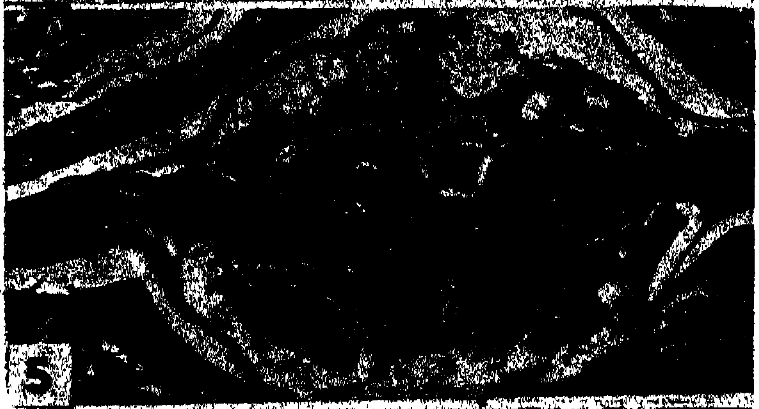
FIG. 1. Photomicrograph—Method IV. Modification A. "Gross" nerve cell in supra-esophageal ganglion.

FIG. 2. Photomicrograph—Miller's Method A. Frontal section through ganglion.

FIG. 3. Photomicrograph—Method II. Cross-section through mid-body ganglion.

PLATE I




5

employing a variety of techniques when undertaking a comprehensive study. This necessitates the employment of diverse methods. In the study of no other tissue are these factors more important. Each new variation in technique supplements, rather than displaces, an established procedure. Each series adds its contribution to the total picture. The procedures which follow were found to be the most applicable, and the preparations the most usable.

I. Cajal-deCastro modification.

1. Relax animal according to method III.
2. Kill and fix in ammoniated absolute alcohol, 24 hours; *14 drops concentrated ammonia* to 100 cc. alcohol.
3. Dissect nervous system, then wash in 50% alcohol.
4. Place tissue in 6% silver nitrate, 72 hours, at 37° C., in dark.
5. Wash in distilled water.
6. Reduce 24 hours in dark in

10% neutral formalin	20 cc.
Hydroquinone	2 gm.
Distilled water	200 cc.

7. Wash in several changes of distilled water.
8. Tone in 0.2% gold chloride, 30 minutes.
9. Wash in several changes of distilled water.
10. Fix in 5% hyposulphite of soda, 30 seconds.
11. Wash in several changes of distilled water.
12. Dehydrate, as directed in method II.
13. Clear as in method II.
14. Infiltrate and embed by method I.
15. Section.
16. Clear as stated in method III.
17. Mount in clarite.

It will be noted that the amount of ammonia may be varied according to the specific nature of the nervous system used. Too much ammonia has a tendency to produce a faded out picture. It was noted that in sections containing both cerebral ganglia and ventral nerve cord, the two regions were not equally impregnated.

II. Bielschowsky modification.

1. Relax animal according to method I.
2. Kill and fix as described in method I, II, and IV. (Series employing each fixative.)
3. Dehydrate, method II, III.
4. Clear, method I and II.
5. Infiltrate and embed, method I.
6. Section, 10μ.
7. Mount, remove paraffin, and gradually hydrate.
8. Wash in distilled water.
9. Place slides in 20% silver nitrate, one hour at room temperature.
10. Wash quickly in distilled water (two dips in each of two changes) and place in
11. Ammoniated silver nitrate prepared as in 14B, Miller's Method.
12. Wash quickly in distilled water.
13. Sections to 10% formalin, 30 seconds.
14. Wash in distilled water; several changes.
15. Tone in 0.2% gold chloride, 20 minutes.
16. Wash in distilled water.
17. Reduce in 2.0 oxalic acid, plus 1 cc. of 40% formalin per 100 cc. of solution, 30 seconds.
18. Wash in distilled water.
19. Fix in 2.0% hyposulphite of soda, 2 minutes.
20. Wash in several changes of distilled water.
21. Dehydrate, method I.
22. Clear, method III.
23. Mount in clarite.

EXPLANATION OF PLATE II

FIG. 4. Photomicrograph—Method III. Cross-section through caudal ganglion.
FIG. 5. Photomicrograph—Method I. Cross-section through mid-body ganglion.
FIG. 6. Photomicrograph—Method III. Cross-section through subesophageal ganglion.

III. Masson stain.

This standard stain technique was used with variations as indicated in the following:

1. Relaxing, method I
2. Killing and fixing, method II and III.
3. Dehydration, method II.
4. Clearing, method II.
5. Infiltration and embedding, method I.
6. Section, mount and remove paraffin.
7. Gradual hydration, stain 5 minutes in Mayer's haemalum.
8. Rinse in distilled water, wash in tap water until blue, and return to distilled water.
9. Stain 5 minutes in

2 pints ponceau de xylidine 1%	In 1% acetic acid in
1 pint Acid fuchsin	distilled water.

10. Rinse in distilled water, 2 changes.
11. Mordant 5 minutes in 5% phosphotungstic acid.
12. Rinse in distilled water.
13. Stain 5 minutes in 2% aniline blue in 2% acetic acid.
14. Rinse in distilled water.
15. Sections to 1% acetic acid, 5 minutes.
16. Sections transferred to distilled water, then
17. Direct to 95% alcohol. Differentiate in 95%. Several changes; if stain is light pass through quickly. If blue has overstained, place slides in 70% alcohol overnight and restain.
18. Five minutes in half absolute and half xylene.
19. Xylene; two changes, each 5 minutes.
20. Mount in clarite.

It will be noted that there are several minor changes from the regular routine, particularly with reference to the killing and fixing procedure. This stain gave excellent cellular and tissue differentiation.

IV. Mallory's phosphotungstic acid hematoxylin method.

Modifications in this technique were largely confined to variations in killing and fixing procedure. This method provided a valuable series of sections illustrating not only the intra-cellular fibrils, but cytological details of ganglion cells. Mallory and Parker in McClung have described the preparation of the stain and certain prescribed steps. Leech material was prepared by the writer using the following combinations of relaxing, killing, and fixing methods followed by paraffin embedding.

1A. Relax by method I, kill and fix, method I.
2A. Dehydrate by method III, clear, method I, embed, method I.
1B. Relax by method III, kill and fix, method II.
2B. Dehydrate, method II, clear, method II, embed, method I.
1C. Relax by method I, kill and fix, method IV.
2C. Dehydrate, method II, clear, method II, embed, method I.

For the convenience of the reader, the following condensed outline of the routine procedure as given by McClung follows:

1. Sections hydrated (if Helly's fixative was used, treat sections in 70% to which has been added iodine) 0.4% iodine in 70% alcohol, 3 minutes. Bleach and wash in 0.25% sodium hyposulphate, 3 minutes. Wash in 70% or 50%, 5 minutes. Sections passed through 35% to distilled water.
2. Sections to 0.25% aqueous solution of potassium permanganate, 10 minutes.
3. Wash in several changes of distilled water.
4. Sections to 5% oxalic acid, 20 minutes.
5. Wash thoroughly in several changes of distilled water.
6. Stain 20–24 hours in Mallory's phosphotungstic acid, hematoxylin.
7. Sections direct to 95% alcohol (quick).
8. Sections to absolute (quick).
9. Sections to absolute and xylene, 50–50.
10. Sections to xylene, 2 changes.
11. Mount in clarite.

It will be noted that this procedure follows the recommendations of Mallory, with the exception of the killing and fixing agents employed, and the special treatment following Helly's fixative.

V. Formal thionin technique as applied to the leech.

1. Relax by method II.
2. Kill, fix and stain, 26 days in the following:
   .25% thionin.
   10% formalin.
3. Dehydrate in dioxane, 3 changes of 3 hours each.
4. Clear by method I.
5. Infiltrate and embed by method I.
6. Section, mount, remove paraffin in two changes of xylene (five minutes), add clarite and cover slip.

The sections so prepared are usable in general morphological study. It is not intended the thionin be presented as a neurological stain. It produces, however, a pleasing picture of the general morphology of the tissue, and is extremely useful in orientation.

REFERENCES

Bodian, D. 1936. A New Method for Staining Nerve Fibers and Nerve Endings in Mounted Paraffin Sections. Anat. Rec. 65: 89–97.

1937. The Staining of Paraffin Sections of Nervous Tissue with Activated Protargol. Anat. Rec. 69: 153–162.

Caskell, J. F. 1914. The Chromaffin System of Annelids. Phil. Trans. Roy. Soc. London, B 205–153–211.

Goldin, L. S. 1937. Double Impregnation of Nervous Tissue. Arch. Russ. Anat. Hist. Embr.–16.

Guyer, Michael F. 1936. Animal Micrology. Univ. of Chicago Press, Illinois

Kernohan, J. W. 1930. Am. Micro. Soc., Vol. 49, No. 1.

Lee, Bolles. 1937. The Microtomist's Vade-Mecum. Edit. Gatenby and Painter. 10th Edition, Churchill, London.

MacFarland, W. E. and **Davenport, H. A.** Staining Paraffin Sections with Protargol. Stain Tech. 16: 53–58.

McClung, C. E. and others. 1937. Handbook of Microscopical Technique. 2nd Revised Edition, Hoeber, New York.

Miller, John A. 1933. Studies in the Biology of the Leech. I. The Subepidermal Nerve Plexus of the Leech *Haemopis marmoratis* (Say). Ohio Jour. Sci., 33: 460–463.

1944. Studies in the Biology of the Leech. VII. A New Method of Staining Nervous Tissue. Ohio Jour. Sci. 44: 31–35.

Statistical Adjustment

This book appears to be destined to exert considerable influence on the statistical analysis of data gathered in the industrial, economic, sociological, and biological fields. The emphasis, as the title suggests, is throughout placed upon the adjustment of observed data by the method of "least squares." The author demonstrates the wide applicability of this method, first by introducing a few simple illustrations, next by developing the fundamental theory, and finally by considering conditions without and conditions with parameters. Throughout, systematic computing forms are included to enable a user of the method of least squares to reach a numerical conclusion efficiently—a conclusion that may be used for action.

This volume may be used as a text in advanced courses in statistical methods, but is likely to find greater usefulness among research workers and practicing statisticians. As a novelty, the case in which both x and y observations are subject to error is discussed and illustrated as the second of four examples appended at the close of the formal development.

The author has spent sixteen years in the government service, in the Bureau of the Census and the Bureau of the Budget, and has had opportunity to test in practice the methods outlined in this book.—*E. L. Green.*

Statistical Adjustment of Data, by W. Edwards Deming. x+261 pp. 24 figs. New York, John Wiley and Sons. 1943. $3.50.

ADDITIONS TO THE REVISED CATALOGUE OF OHIO VASCULAR PLANTS. XII.[1]

CLYDE H. JONES,
The Ohio State University

In spite of travel restrictions, amateur botanists throughout the State have contributed their usual number of specimens to the Herbarium during the past year. Unfortunately, some collections have remained unexamined due to the lack of "man-power" for assistance and to the temporary assignment of herbarium personnel to the teaching of Army classes on the campus. The Curator, however, wishes to thank the numerous collectors for their continued interest and promises a report in detail on their contributions as soon as time and assistance permit.

Without doubt the most important single acquisition of the year is the L. S. Hopkins pteridophyte herbarium consisting of approximately 6200 specimens in excellent condition. In addition, Mr. Hopkins has contributed over 500 specimens representing other families. This latter collection consists for the most part of specimens from the northeastern counties of Ohio. It is particularly valuable as many of the habitats in which these plants were found have since been destroyed.

H. W. Rickett, of the New York Botanical Garden, an authority on the *Cornaceae,* has examined our *Cornaceae* collections and suggested various changes in identification and nomenclature. These changes and the distribution of species by counties are included in their proper numerical position in this report.

Certain entries in the following list of additions are cited by location only, the collector's name being omitted. Such specimens were collected by John N. Wolfe, Richard T. Wareham, and Herbert T. Scofield in the Sugar Grove region during the past five years in connection with their study of the microclimates of that area. To date they have contributed 76 county records, herein recorded for the first time.

The following list of plants represents a majority of the new county and state records which have been added to the State Herbarium during the past year.

7. *Botrychium virginianum* (L.) Sw. Virginia Grape-fern. Good Hope Twp., Hocking Co.
10. *Osmunda cinnamomea* L. Cinnamon-fern. Good Hope Twp., Hocking Co.
27.1. *Asplenium bradleyi* D. C. Eaton. Bradley's Spleenwort. Jackson Twp., Pike Co. Floyd Bartley.
56. *Equisetum nelsoni* (A. A. Eat.) Schaffn. Nelson's Scouring-rush. Ashtabula Co. L. E. Hicks.
61. *Equisetum arvense* L. Field Horsetail. Good Hope Twp., Hocking Co.
101.1. *Potamogeton crispus* L. Curly Pondweed. Buckeye Lake, Licking Co. State Department of Conservation via G. W. Blaydes.
129. *Spathyema foetida* (L.) Raf. Skunk-cabbage. Good Hope Twp., Hocking Co.
130. *Peltandra virginica* (L.) Kunth. Green Arrow-arum. Good Hope Twp., Hocking Co.
140. *Scirpus lineatus* Mx. Reddish Bulrush. Wayne Co. L. S. Hopkins.
142. *Scirpus sylvaticus* L. Wood Bulrush. Wayne Co. L. S. Hopkins.
145.2. *Scirpus occidentalis* (Matson) Chase. Viscid Great Bulrush. Ashland Co. L. S. Hopkins.
148. *Scirpus americanus* Pers. Chair-maker's Rush. Medina Co. L. S. Hopkins.
165. *Eleocharis obtusa* (Willd.) Schultes. Blunt Spikerush. Good Hope Twp., Hocking Co.
176. *Cyperus esculentus* L. Nut-grass. Hocking Twp., Fairfield Co. Charles R. Goslin.
398. *Sporobolus cryptandrus* (Torr.) Gr. Sand Dropseed. Lake Co. L. E. Hicks.
409. *Cinna arundinacea* L. Wood Reed-grass. Highland Co. L. S. Hopkins.
442.1. *Aegilopsis cylindrica* Host. Jointed Goatgrass. Cincinnati, Hamilton Co. Loise Clermont.

---

[1] Papers from the Department of Botany, The Ohio State University, No. 470.

455. *Capriola dactylon* (L.) Ktz. Bermuda-grass. Pickaway Co. C. J. Willard.

460. *Homalocenchrus virginicus* (Willd.) Britt. Virginia Cut-grass. Highland Co. L. S. Hopkins.

467. *Panicum dichotomiflorum* Mx. Spreading Panic-grass. Medina Co. L. S. Hopkins.

483. *Panicum polyanthes* Schultes. Many-flowered Panic-grass. Belmont Co. Emma E. Laughlin.

489. *Panicum tennesseense* Ashe. Tennessee Panic-grass. Wayne Co. L. S. Hopkins.

494. *Panicum implicatum* Scribn. Slender-stemmed Panic-grass. Wayne Co. L. S. Hopkins.

495. *Panicum commutatum* Schultes. Variable Panic-grass. Wayne Co. L. S. Hopkins.

496. *Panicum clandestinum* L. Hispid Panic-grass. Wayne Co. L. S. Hopkins.

503. *Echinochloa crus-galli* (L.) Beauv. Common Barnyard-grass. Highland Co. L. S Hopkins.

535. *Allium vineale* L. Field Garlic. Seneca Co. Kenneth Rinehart via C. J. Willard.

537. *Allium sibiricum* L. Siberian Chives. Franklin Co. C. J. Willard.

561. *Trillium sessile* L. Sessile Trillium. Perry Co. Floyd and Elizabeth Clum.

564. *Uvularia perfoliata* L. Perfoliate Bellwort. Good Hope Twp., Hocking Co.

565. *Uvularia grandiflora* Sm. Large-flowered Bellwort. Good Hope Twp., Hocking Co

570. *Polygonatum biflorum* (Walt.) Ell. Hairy Solomon's-seal. Good Hope Twp., Hocking Co.

579. *Smilax scirrhata* (Engelm.) Wats. Upright Smilax. Good Hope Twp., Hocking Co

628. *Iris virginica* L. Virginia Blue-flag. Good Hope Twp., Hocking Co.

639. *Galeorchis spectabilis* (L.) Rydb. Showy Orchis. Good Hope Twp., Hocking Co.

665. *Isotria verticellata* (Willd.) Raf. Whorled Isotria. Tar Hollow, Ross Co. Clyde H. Jones.

668. *Liparis loeselii* (L.) Rich. Fen Twayblade. Tar Hollow, Ross Co. Ethel Harper.

670. *Aplectrum hyemale* (Muhl.) Torr. Putty-root. Good Hope Twp., Hocking Co.

681. *Ranunculus abortivus* L. Kidney-leaf Crowfoot. Perry Co. Floyd and Elizabeth Clum. Good Hope Twp., Hocking Co.

690. *Ranunculus hispidus* Mx. Hispid Buttercup. Good Hope Twp., Hocking Co.

693. *Ranunculus obtusiusculus* Raf. Lance-leaf Buttercup. Wayne Co. L. S. Hopkins.

750. *Sanguinaria canadensis* L. Bloodroot. Perry Co. Floyd and Elizabeth Clum. Good Hope Twp., Hocking Co.

754. *Bicuculla cucullaria* (L.) Millsp. Dutchman's-breeches. Perry Co. Floyd and Elizabeth Clum.

762. *Berteroa incana* (L.) DC. Hoary Berteroa. Lake Co. Fred Tyler.

765. *Draba verna* L. Vernal Whitlow-grass. Good Hope Twp., Hocking Co.

793. *Cheirinia inconspicua* (Wats.) Britt. Prairie Cheirinia. Athens Co. Walter P. Porter and P. S. Wamsley.

809. *Arabis glabra* (L.) Bernh. Tower Mustard. Hocking Twp., Fairfield Co. Charles R. Goslin.

826. *Dentaria laciniata* Muhl. Cutleaf Toothwort. Good Hope Twp., Hocking Co.

857. *Oxalis stricta* L. Upright Wood-sorrel. Good Hope Twp., Hocking Co.

861. *Oxalis corniculata* L. Procumbent Wood-sorrel. Wayne Co. L. S. Hopkins.

863. *Oxalis violacea* L. Violet Wood-sorrel. Good Hope Twp., Hocking Co.

873. *Impatiens biflora* Walt. Spotted Touch-me-not. Berne Twp., Fairfield Co. Charles R. Goslin.

882. *Polygala viridescens* L. Purple Milkwort. Good Hope Twp., Hocking Co.

890.1. *Croton glandulosus* L. Glandular Croton. Adams Co. Conrad Roth.

907. *Chamaesyce preslii* (Guss.) Arth. Nodding Spurge. Good Hope Twp., Hocking Co.

908. *Chamaesyce humistrata* (Engelm.) Small. Hairy Spreading Spurge. Medina Co. L. S. Hopkins.

964. *Viola eriocarpa* Schw. Smooth Yellow Violet. Good Hope Twp., Hocking Co.

971.1. *Viola arvensis* Murr. European Field Pansy. Belmont Co. Emma E. Laughlin Adams Co. Conrad Roth.

980. *Viola papilionacea* Pursh. Common Blue Violet. Good Hope Twp., Hocking Co.

988. *Viola sagittata* Ait. Arrow-leaf Violet. Adams Co. John N. Wolfe.

1001. *Alsine media* L. Common Chickweed. Good Hope Twp., Hocking Co.

1018. *Silene stellata* (L.) Ait. f. Starry Campion. Good Hope Twp., Hocking Co.

1038. *Claytonia virginica* L. Spring-beauty. Good Hope Twp., Hocking Co.

1043. *Phytolacca americana* L. Pokeweed. Good Hope Twp., Hocking Co.

1065. *Chenopodium boscianum* Moq. Bosc's Goosefoot. Greenfield Twp., Fairfield Co. Charles R. Goslin.

1074. *Atriplex hastata* L. Halberd-leaf Orache. Hocking Twp., Fairfield Co.

1080. *Steironema ciliatum* (L.) Raf. Fringed Yellow Loosestrife. Good Hope Twp., Hocking Co.

1114. *Persicaria punctata* (Ell.) Small. Dotted Smartweed. Good Hope Twp., Hocking Co.

1123. *Polygonum aviculare* L. Doorweed. Hocking Twp., Fairfield Co. Charles R. Goslin.

1129. *Geum canadense* Jacq White Avens. Good Hope Twp., Hocking Co

1179. *Agrimonia parviflora* Sol. Small-flowered Agrimonia. Good Hope Twp., Hocking Co.

1248. *Trifolium agrarium* L Yellow Hop Clover. Wayne Co L. S. Hopkins.

1287. *Meibomia grandiflora* (Walt.) Ktz. Pointed-leaf Tick-trefoil. Good Hope Twp., Hocking Co.

1325. *Strophostyles helvola* (L.) Britt. Trailing Wild Bean. Belmont Co. Emma E. Laughlin.

1330. *Sedum ternatum* Mx Wild Stonecrop. Good Hope Twp., Hocking Co.

1331. *Penthorum sedoides* L. Ditch Stonecrop. Good Hope Twp., Hocking Co.

1366. *Parthenocissus quinquefolia* (L.) Planch. Virginia Creeper. Good Hope Twp., Hocking Co.

1386. *Acer saccharinum* L. Silver Maple. Good Hope Twp., Hocking Co.

1387. *Acer negundo* L. Boxelder. Good Hope Twp., Hocking Co.

1417. *Fagus grandifolia* Ehrh. American Beech. Good Hope Twp., Hocking Co.

1431. *Quercus coccinea* Wang. Scarlet Oak. Good Hope Twp., Hocking Co

1432. *Quercus borealis* Michx. var. *maxima* (Marsh.) Ashe. Red Oak. Tar Hollow, Ross Co Clyde H. Jones.

1433. *Quercus palustris* Du Roi. Pin Oak Greenfield Twp., Fairfield Co Charles R Goslin.

1438 *Betula lutea* Mx f. Yellow Birch. Revenge, Fairfield Co.

1452. *Juglans nigra* L Black Walnut. Good Hope Twp., Hocking Co.

1453. *Juglans cinerea* L. Butternut. Good Hope Twp., Hocking Co.

1470. *Salix vitellina* L. Yellow Willow. Tar Hollow, Ross Co. Clyde H. Jones.

1493. *Grossularia cynosbati* (L.) Mill. Prickly Gooseberry. Perry Co. Floyd and Elizabeth Clum.

1532. *Asarum canadense* L. Canadian Wild Ginger. Good Hope Twp., Hocking Co.

1555. *Hypopitys americana* (DC) Small. Smooth Pinesap. Tar Hollow, Ross Co. Arthur R. Harper.

1579. *Phlox divaricata* L. Wild Blue Phlox. Good Hope Twp., Hocking Co

1619. *Fraxinus biltmoreana* Bead. Biltmore's Ash. Tar Hollow, Ross Co. Clyde H. Jones

1629. *Gentiana flavida* Gr. Yellow Gentian. Bear Creek, Scioto Co. Don Durnell via John N. Wolfe.

1637. *Apocynum medium* Greene. Intermediate Dogbane. Wayne Co L. S. Hopkins.

1646. *Asclepias incarnata* L. Swamp Milkweed. Good Hope Twp., Hocking Co.

1671. *Physalis heterophylla* Nees. Clammy Ground-cherry. Wayne Co. L. S. Hopkins

1678. *Solanum nigrum* L. Black Nightshade. Cedar Falls, Hocking Co. John N. Wolfe.

1682. *Verbascum blattaria* L. Moth Mullen. Good Hope Twp., Hocking Co

1693. *Chelone montana* var. *elatior* (Raf.) P. & W. Mountain Turtle-head. Fairfield Co.

1696 *Collinsia verna* Nutt. Blue-eyed-Mary Pleasant Twp., Fairfield Co. Velma Beougher via Charles R. Goslin.

1740. *Chaenorrhinum minus* (L.) Lange. Lesser Toadflax. Berne Twp., Fairfield Co. Charles R. Goslin.

1767 *Lappula virginiana* (L.) Greene. Virginia Stickseed. Good Hope Twp., Hocking Co.

1787. *Verbena urticaefolia* L. White Vervain. Good Hope Twp., Hocking Co.

1793. *Lippia lanceolata* Mx. Frog-fruit. Hocking Co.

1799. *Teucrium occidentale* Gr. Hairy Germander. Wayne Co. L. S. Hopkins.

1820. *Mentha canadensis* L. American Wild Mint. Medina Co. L. S. Hopkins.

1823. *Lycopus virginicus* L. Virginia Water-hoarhound. Hocking Co.

1824. *Lycopus uniflorus* Mx. Northern Water-hoarhound. Good Hope Twp., Hocking Co.

1828. *Koellia flexuosa* (Walt.) MacM. Narrow-leaf Mountain-mint. Licking Co. H. E. Eswine.

1870. *Blephilia hirsuta* (Pursh.) Torr. Hairy Blephilia. Hocking Co.

1902. *Deringa canadensis* (L.) Ktz. Honewort. Good Hope., Hocking Co.

Cornaceae. Dogwood Family

1935. *Cornus alternifolia* L. f. Blue Dogwood. Greene, Clark, Champaign, Highland, Adams, Scioto, Ross, Pickaway, Franklin, Jackson, Hocking, Fairfield, Licking, Knox, Morrow, Richland, Huron, Erie, Lorain, Wayne, Coshocton, Muskingum, Meigs, Noble, Monroe, Belmont, Harrison, Jefferson, Carroll, Stark, Summit, Cuyahoga, Lake, and Ashtabula Counties.

1936. *Cornus amomum* Mill. Silky Dogwood. Defiance, Adams, Jackson, Meigs, Hocking, Licking, Stark, Medina, and Trumbull Counties.

1936.1. *Cornus purpusi* Koehne (*C. obliqua*). Oblique Dogwood. Montgomery, Greene, Fayette, Clark, Champaign, Logan, Auglaize, Williams, Lucas, Franklin, Fairfield, Coshocton, Wayne, Richland, Huron, and Ashtabula Counties.

1936.2. *Cornus amomum* Mill. x *C. purpusi* Koehne. Clark, Scioto, Franklin, Fairfield, Coshocton, Stark, Summit, Erie, and Ottawa Counties.

1937. *Cornus drummondi* Meyer. (This species has long been known as *C. asperifolia*, which is a species of the southeastern coastal plains.) Drummond's Dogwood. Hamilton, Clermont, Adams, Lawrence, Butler, Warren, Ross, Montgomery, Pickaway, Greene, Morgan, Miami, Clark, Madison, Franklin, Licking, Muskingum, Shelby, Logan, Knox, Coshocton, Auglaize, Hardin, Lucas, Wood, Ottawa, Erie, Lorain and Cuyahoga Counties.
1938. *Cornus rugosa* Lam. Roundleaf Dogwood Warren, Ross, Lorain, Cuyahoga, Summit, Geauga, Lake, and Ashtabula Counties.
1939. *Cornus racemosa* Lam. (*C. paniculata*, *C. femina*, *C. candidissima*). Racemed Dogwood. Van Wert, Defiance, Williams, Fulton, Lucas, Wood, Hancock, Hardin, Clark, Clinton, Highland, Adams, Ross, Hocking, Fairfield, Delaware, Wyandot, Muskingum, Coshocton, Richland, Erie, Lorain, Wayne, Belmont, Tuscarawas, Carroll, Stark, Cuyahoga, Geauga, and Lake Counties.
1940 *Cornus stolonifera* Mx Red-osier Dogwood. Lucas, Huron, Stark, Summit, Cuyahoga, Lake, and Ashtabula Counties.
1941. *Cornus florida* L. (*Cynoxylon floridum*) Flowering Dogwood. Williams, Fulton, Defiance, Lucas, Logan, Auglaize, Miami, Clark, Preble, Montgomery, Greene, Butler, Warren, Hamilton, Clermont, Brown, Adams, Scioto, Highland, Pike, Jackson, Gallia, Ross, Vinton, Hocking, Fairfield, Franklin, Licking, Delaware, Morgan, Morrow, Wyandot, Richland, Huron, Lorain, Cuyahoga, Medina, Summit, Stark, Wayne, Holmes, Tuscarawas, Washington, Noble, Monroe, Belmont, Harrison, Carroll, Columbiana, and Trumbull Counties.
1942. *Cornus canadensis* L. (*Cynoxylon canadense*). Bunchberry or Dwarf Dogwood. Licking, Stark, Portage, Geauga, Lake, and Ashtabula Counties.

1951. *Cephalanthus occidentalis* L Buttonbush. Good Hope Twp., Hocking Co.
1959. *Galium lanceolatum* Torr. Lanceleaf Wild Licorice Hocking Twp , Fairfield Co. Charles R. Goslin.
2013. *Campanula aparinoides* Pursh. Marsh Bellflower. Good Hope Twp., Hocking Co.
2019. *Lobelia inflata* L Indian Tobacco. Good Hope Twp., Hocking Co
2030. *Heliopsis helianthoides* (L.) Sw. Smooth Oxeye. Good Hope Twp , Hocking Co.
2038. *Rudbeckia triloba* L Thin-leaf Cone-flower. Good Hope Twp , Hocking Co.
2039. *Rudbeckia laciniata* L Tall Cone-flower Wayne Co L. S Hopkins.
2072. *Bidens laevis* (L.) B. S. P Smooth Bur-marigold Good Hope Twp , Hocking Co.
2073. *Bidens cernua* L. Nodding Bur-marigold. Good Hope Twp., Hocking Co.
2080.1. *Bidens involucrata* (Nutt.) Britt. Long-bracted Tickseed Valley of the Hocking River, Athens Co P S. Wamsley and Walter P. Porter.
2112. *Antennaria plantaginifolia* (L) Rich. Plantain-leaf Everlasting Good Hope Twp , Hocking Co.
2128 *Solidago rigidiuscula* (T & G.) Port. Slender Showy Goldenrod Good Hope Twp., Hocking Co.
2134. *Solidago ulmifolia* Muhl. Elmleaf Goldenrod. Geauga Co. L. S. Hopkins
2150. *Aster shortii* Hook. Short's Aster. Hocking Co. Warren Jacobs.
2151. *Aster azureus* Lindl. Azure Aster. Hocking Co. Warren Jacobs.
2152. *Aster cordifolius* L. Common Blue Wood Aster. Hocking Co. Warren Jacobs
2153. *Aster lowrieanus* Port. Lowrie's Aster Hocking Co
2157. *Aster undulatus* L Wavy-leaf Aster. Fairfield Co.
2158. *Aster puniceus* L Purple-stem Aster. Good Hope Twp , Hocking Co.
2163. *Aster prenanthoides* Muhl. Crooked-stem Aster. Hocking Co. Warren Jacobs.
2164. *Aster laevis* L. Smooth Aster. Hocking Co.
2165. *Aster concinnus* Willd. Narrow-leaf Smooth Aster. Hocking Co. Warren Jacobs.
2167. *Aster lateriflorus* (L.) Britt. Starved Aster. Good Hope Twp., Hocking Co.
2169. *Aster vimineus* Lam Small White Aster. Hocking Co. Warren Jacobs
2174. *Aster tradescanti* L Tradescant's Aster. Good Hope Twp., Hocking Co.
2179. *Erigeron philadelphicus* L. Philadelphia Fleabane. Good Hope Twp., Hocking Co.
2180. *Erigeron ramosus* (Walt.) B. S. P. Daisy Fleabane. Good Hope Twp , Hocking Co.
2184. *Doellingeria umbellata* (Mill.) Nees. Tall Flat-top Aster. Wayne Co. L. S. Hopkins.
2195. *Eupatorium aromaticum* L. Smaller Snake-root. Good Hope Twp , Hocking Co.
2204. *Vernonia altissima* Nutt. Tall Ironweed. Good Hope Twp., Hocking Co.
2212. *Achillea millefolium* L. Common Milfoil. Fairfield Co.
2239. *Erechites hieracifolia* (L.) Raf. Fireweed. Good Hope Twp., Hocking Co.

BOOK NOTICES

All about Virus Diseases

Anyone wishing to be brought up to date concerning virus diseases should read Seiffert's "Virus Diseases in Man, Animal and Plant." Here can be found a comprehensive survey of present day knowledge of the subject. The book is composed of six divisions. In the first division general concepts of vira and their behavior are discussed. The second and largest division takes up 182 pages, in which 78 virus diseases in man, animals and plants are discussed. One division is concerned with virus-like organisms and another with filtrable types of bacteria. One division takes up the various methods of virus investigation. The final section is a reference index.—*D. C. Rife.*

Virus Diseases in Man, Animal and Plant. Gustav Seiffert. VI Divisions, 332 pp. The Philosophical Library, New York. 1944.

Genes and the Man

"Genes and the Man" may more appropriately be thought of as an elementary text book of human biology than as one of genetics. While genetic principles are stressed throughout, much of the book has to do with embryology and physiology. There are six chapters, which vary considerably in length. Chapter V, entitled "From Potentialities to Realization," is the longest, covering 128 pages, and is almost entirely devoted to human embryology. The shortest chapter, "On Growing Old," is only 23 pages in length, and, as one might surmise, deals with longevity. One chapter deals exclusively with sex, giving a discussion of the evolution of sexuality, as well as sex determination and sex-linked factors. The book contains a wealth of material and is well illustrated. "Genes and the Man" should make a good text for serious minded college students who take only one course dealing with human biology.—*D. C. Rife.*

Genes and the Man. Bentley Glass. VI Chapters, 386 pp. Columbia University Press. 1943.

Alaska Diary

The late Ales Hrdlicka, one of the most widely known anthropologists in America, was Curator of Physical Anthropology at the United States National Museum for thirty-three years. In 1926 he decided to go to Alaska in search of evidence which would throw light upon the entry of man into the New World from Asia across Bering Strait. *Alaska Diary* consists of the daily record of this journey along with the day by day accounts of his three following expeditions made in 1929, 1930 and 1931.

Traveling by boat, the author explored the lower portions of the Yukon River, the Kuskokwim River, and the Nushagak River. The diary, which makes no pretense to literary style, deals largely with details of traveling through a poorly settled country and with the minor hardships encountered on the trips. He stopped at "old" and "new" village sites of both the Indians and Eskimos. At the modern villages he would measure the adults and give free medical treatment to those who were ailing and at the old and abandoned sites he would collect human skeletons and artifacts. He soon became known to the natives along the rivers as the "skull doctor" and in the main was well received by them. Mosquitoes and other biting insects, along with barking dogs, made it hard to get enough sleep but the author showed remarkable endurance for a man of his age.

Alaska Diary does not make smooth reading and if one is looking for information pertaining to the "customs, traditions and characteristics" of the natives of the region he will be disappointed. Physical anthropologists and archaeologists probably will question the value of some of the material for scientific purposes but it must pe kept in mind that this was a pioneering work. Its greatest value may well prove to be the information it contains concerning the locations of archaeological sites. Many sites were untouched by Hrdlicka due to lack of time, lack of assistance, and the frozen condition of the ground. The future archaeologist working in the area will have much of the reconnaissance work already done for him and can excavate some of the more important sites without further search.

The illustrations showing Indian and Eskimo types and scenes along the rivers add considerably to the book's interest even though they are not so good from the technical standpoint. Those interested in the scientific aspects of the expeditions may consult the various reports which are mentioned at the end of the book. *Alaska Diary* will be of interest to anyone planning to travel in Alaska or to the reader who likes to travel vicariously.—*Richard G. Morgan.*

Alaska Diary, by Ales Hrdlicka, The Jacques Cattell Press, Lancaster, Pennsylvania. 1943. xv—414 pp., 232 Illus., $5.00.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIV SEPTEMBER, 1944 No. 5

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE
1944

THE OHIO ACADEMY OF SCIENCE

Organized 1891 Incorporated 1892
Affiliated with the American Association for the Advancement of Science

OFFICERS AND COMMITTEES FOR 1944-1945

President

J. ERNEST CARMAN

Vice-Presidents

A. *Zoology:* MARION BOESEL
B. *Plant Science:* W. B. STEIDTMANN
C. *Geology:* GEORGE W. WHITE
D. *Medical Science:* L. F. EDWARDS
E. *Psychology:* ARTHUR G. BILLS
F. *Physics and Astronomy:* C. W. JARVIS
G. *Geography:* JAMES R. BECK
H. *Chemistry:* ROY G. BOSSERT
I. *Mathematics:* E. I. YOWELL
J. *Junior Academy:* PHILIP DYE
K. *Anthropology:* RICHARD G. MORGAN

Secretary

A. W. LINDSEY

Treasurer

CLARENCE E. TAFT

Historian

WILLIAM H. ALEXANDER

Executive Committee

Ex-Officio: J. E. CARMAN, A. W. LINDSEY AND C. E. TAFT
Elective: G. W. BLAYDES AND GEORGE W. WHITE

Trustees of the Research Fund

F. C. BLAKE, term expires	1945
M. E. STICKNEY, term expires	1946
HERBERT OSBORN, *Chairman*, term expires	1947

Library Committee

Mrs. Ethel M. Miller, *Chairman*

Librarian in charge of Academy Exchanges and Publications

William Lloyd Evans, term expires	1945
A. C. Anderson, term expires	1946

Committee on Conservation

E. Lucy Braun, term expires	1945
E. S. Thomas, term expires	1945
Wilber Stout, term expires	1945
Roscoe E. Franks, term expires	1946
T. H. Langlois, *Chairman*, term expires	1946
E. L. Wickliff, term expires	1946
G. W. Conrey, term expires	1947
L. C. Dow, term expires	1947
E. W. E. Schear, term expires	1947

Committee on Nominations for 1944–1945

The Vice-Presidents of 1943–1944—E. W. E. Schear, *Chairman*

Membership Committee for 1944–1945

A. *Zoology:* William C. Beaver

B. *Plant Science:* C. J. Willard, *Chairman*

C. *Geology:* K. C. Cottingham

D. *Medical Science:* Normand L. Hoerr

E. *Psychology:* Herbert A. Toops

F. *Physics and Astronomy:* J. L. Glathart

G. *Geography:* F. J. Wright

H. *Chemistry:* Paul Rothemund

I. *Mathematics:* *

J. *Junior Academy:* D. C. Fast

K. *Anthropology:* F. G. Detweiler

Committee on Necrology

George D. Hubbard, term expires	1945
F. H. Krecker, *Chairman*, term expires	1946
Charles G. Shatzer, term expires	1947

Committee on Resolutions

C. E. O'Neal, term expires	1945
P. M. Rea, term expires	1946
Eugene Van Cleef, term expires	1947

Academy Representatives

1. On the Joint Administrative Board of the Ohio Journal of Science:

William Lloyd Evans, term expires	1945
A. C. Anderson, term expires	1946

2. On the Council of the A. A. A. S.: A. W. Lindsey.
3. On the Save-Outdoor-Ohio Council: Roscoe W. Franks.

The Council for 1944–1945

Anderson, A. C.
Beaver, William C.
Beck, James R.
Bills, Arthur G.
Blaydes, Glenn W.
Boesel, Marion
Bossert, Roy G.
Carman, J. Ernest
Cottingham, K. C.
Detweiler, F. J.
Dye, Philip
Edwards, L. F.
Evans, William Lloyd
Fast, D. C.
Glathart, Justin L.
Hoerr, Normand L.
Jarvis, C. W.
Krecker, F. H.
Langlois, T. H.
Lindsey, A. W.
Miller, Mrs. Ethel M.
Miller, John A.
Morgan, Richard G.
Osborn, Herbert
Rothemund, Paul
Shetrone, H. C.
Steidtmann, W. B.
Taft, C. E.
Toops, Herbert A.
White, George W.
Willard, C. J.
Wright, F. J.
Yowell, E. I.

---

*The Mathematics Section has not elected a membership committeeman for the year.

REPORT OF THE FIFTY-FOURTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The possibility of holding a meeting this year caused much discussion in the Executive Committee. Thanks to the willingness of members from the Ohio State University to assume responsibility for a second meeting in succession on their campus, plans were made for the usual gathering on May 4, 5 and 6, 1944.

The first meeting was that of the Executive Council at 8:00 P. M. on May 4, in the trustees' room of the Ohio State Museum. This meeting seemed unusually well attended and enthusiastic. No other evening programs had been planned.

Friday was devoted as usual to section programs. The sections on Physics and Astronomy and Mathematics joined forces, since other recent meetings in these fields had curtailed their programs. In spite of this abridgment a total of 94 papers appears in the annual program, in addition to a forum and some discussion periods. Since last year's program included 95 titles, we seem to have found our wartime level at this point. The program of the Junior Academy took place on Saturday, May 6.

The Ohio State Museum displayed an extremely interesting exhibit of enlargements from Dr. E. S. Thomas' nature photographs. For their technical excellence and artistic qualities as well as for their value in the field of nature study they were worthy of careful attention.

The annual banquet and business meeting were held again in the Faculty Club with Dr. L. H. Snyder as toastmaster. Following a greeting from President Howard L. Bevis of the Ohio State University and the response for the Academy by Dr. H. H. M. Bowman of Toledo University, President Shetrone read, as his retiring address, a paper on prehistoric irrigation in Arizona which introduced the group to an amazing chapter of human life in our continent with vivid suggestion of the fascination of archaeological research.

In the annual business meeting the report from the Council included the names of about fifty new members—a fine tribute to the work of section officers during the year—and the names of the following twenty-eight newly elected fellows:

ALLISON, CLYDE C.
BARTLEY, FLOYD
BECK, JAMES R.
CUNNINGHAM, JOHN F.
DELOR, CAMILLE J.
DICKERMAN, E. EUGENE
DOAN, KENNETH H.
EDELMANN, ABRAHAM
EMO, LORENZO
GLATHART, JUSTIN L.
HOLLENBECK, ZEPH J. R.
HUMPHREY, SYLVESTER S.
MILLER, MRS. ETHEL M.
MYERS, R. MAURICE
NORRIS, FREDERICK H.
PONTIUS, LESLIE L.
POPHAM, RICHARD A.
PUPPEL, ITALO D.
RABKIN, SAMUEL
REED, JOHN F.
ROGICK, MARY D.
SHANKS, ROYAL E.
STUMM, ERWIN C.
STURGEON, MYRON T.
SWANSON, CARROLL A.
TAYLOR, MRS. BAYARD
TILFORD, PAUL E.
WEISHAUPT, CLARA G.

Dr. F. G. Detweiler read the report of the Resolutions Committee, expressing the Academy's appreciation to our hosts for again assuming the responsibility for a wartime meeting with such thoroughly gratifying results.

Respectfully submitted,

A. W. LINDSEY, *Secretary.*

REPORT OF THE TREASURER

COLUMBUS, OHIO, May 4, 1944.

To the Ohio Academy of Science:

I submit herewith a financial statement of the condition of the Ohio Academy of Science as of December 31, 1943. The books have been audited and the opinion of the auditor is herewith attached.

Respectfully submitted,

CLARENCE E. TAFT, *Treasurer.*

OHIO ACADEMY OF SCIENCE BALANCE SHEET AS AT DECEMBER 31, 1943

ASSETS

CURRENT EXPENSE FUND:		
Cash on Hand		$ 15.00
Cash in Bank		518.13
Total Cash		$ 533.13
Interest Receivable		19.50
Bonds Owned:		
Federal Farm Loan 1945–55 (cost)	$1,300.00	
War Savings Bond Series F (cost)	111.00	
Total Bonds Owned		1,411.00
Total Assets—Current Expense Fund		$1,963.63
RESEARCH FUND:		
Cash in Bank	$ 234.78	
Banc-Ohio Securities Company Stock (cost)	437.50	
Bonds—Fort Hayes Hotel, Columbus, Ohio (cost)	1,300.00	
Total Assets—Research Fund		1,972.28
TOTAL ASSETS		$3,935.91

LIABILITIES AND NET WORTH

CURRENT EXPENSE FUND:		
Liabilities:		
Accounts Payable		$ 205.50
Deferred Credits:		
1944 Dues collected in 1943		35.00
Total Liabilities and Deferred Credits		$ 240.50
NET WORTH:		
Ohio Academy of Science:		
Current Expense Fund Surplus	$1,723.13	
Research Fund Surplus	1,972.28	
Total Net Worth		3,695.41
TOTAL LIABILITIES AND NET WORTH		$3,935.91

OHIO ACADEMY OF SCIENCE STATEMENT OF INCOME AND EXPENSE

For the Year Ended December 31, 1943

INCOME:			
Dues collected in 1943			$1,372 50
Grants for Research			172 00
Sale of Publications			10 66
Interest on Bonds			39 00
Total Income			$1,594 16
OPERATING EXPENSES:			
Subscriptions, Ohio Journal of Science		$858 75	
Printing:			
Proceedings Ohio Journal of Science	$103 68		
Other Printing	88 03		
Total Printing		191 71	
Research Grants		172 00	
Postage and Telegraph		35 32	
Office Supplies and Expense		28 58	
Expenses—Officers and Committees		25 88	
Secretary's Honorarium		100 00	
Auditing Expenses		15.00	
Bond of Treasurer		5 00	
Safety Deposit Box Rent		3 60	
Bank Charges		13 36	
Total Operating Expenses			1,449 20
EXCESS OF INCOME OVER EXPENSES			$ 144 96

AUDITOR'S CERTIFICATE

COLUMBUS, OHIO, July 1, 1944.

The Ohio Academy of Science,
Columbus, Ohio.

GENTLEMEN:

In accordance with your instructions, I have audited the accounts and records of the Treasurer of the Ohio Academy of Science for the year ended December 31, 1943.

I did not audit the Research Fund.

I hereby certify that in my opinion the books and records of the society are being kept in accordance with accepted accounting principles and the accompanying balance sheet of the Current Expense Fund as at December 31, 1943, and related statement of Income and Expense fairly present the financial condition of the Ohio Academy of Science (Current Expense Fund) and the results of operation for the year ended that date.

Respectfully yours,

DANIEL M. SHONTING,
Certified Public Accountant.

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

The Research Fund of the Academy had a reported balance in the checking account on December 31, 1943, of $284.78. The additions credited during the year 1943 were $46.50 and a grant of $50.00 with service charges at bank of $1.14 gives a balance of $280.14 for December 31, 1943.

SUMMARY OF RECEIPTS AND DISBURSEMENTS

RECEIPTS		
Balance in Bank as of December 31, 1942		$ 284 78
Receipts		46.50
Total		$ 331 28
DISBURSEMENTS		
By grant to Dr. Meyer	$50.00	
Service charges at Bank	1.14	
		51.14
Balance in checking account December 31, 1943		$ 280 14
ASSETS		
Bonds (at cost)		$1,300 00
BancOhio stock (at cost)		437 50
Cash on deposit, Ohio National Bank		280.14
Total		$2,017 64

The allowance from the A. A. A. S. for 1944 is $165.00 and this has been granted, $100.00 to Dr. Meyer for continuation of a study of mineral nutrition of Russian dandelion, and $65.00 to Dr. Venard for further work on Ohio mosquito fauna.

While grants from our Research Fund must be of small amounts, they can give aid and encouragement to projects worthy of assistance and it is desired that they have as wide a distribution as possible for locality and field of investigation. They should not only give aid to worthy projects but stimulate research activity in many places and for many members of the Academy.

Respectfully submitted,

HERBERT OSBORN, *Chairman*,
PAUL B. SEARS,
F. C. BLAKE, *Trustees*.

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The activities of our governing bodies were less extensive than usual, largely due to the serious illness of President Shetrone. The Executive Committee did little but plan for the annual meeting.

At the meeting of the Council February 12, on the campus of the Ohio State University, Dr. F. S. Howlett presided. The question of holding an annual meeting, reported favorably by the Executive Committee, resulted in unanimous approval of the meeting. The possible dates were subjected to a long discussion, due to the unusual conditions imposed on educational institutions by the war. It was finally agreed that the meeting should take place at the Ohio State University on May 4, 5 and 6, 1944. It was evident in the discussion that there is a division of opinion on the time for the annual banquet and business meeting and on the advantages of Saturday or preceding days for programs. Evidently a more general expression of opinion is to be desired on these points. Aside from acting on membership applications the Council considered no other business at this time.

The Annual Meeting of the Council took place in the Trustees Room of the Ohio State Museum at 8:00 P. M., May 4. The reports published herewith were presented at this meeting as required by the Constitution. They show that the affairs of the organization are in a prosperous state, only the circulation of publications apparently suffering rather seriously from the war.

At this meeting Dr. Glenn W. Blaydes of the Department of Botany and Dr. George W. White of the Department of Geology, Ohio State University, were elected to the Executive Committee for the coming year.

Steps were taken to assure the constitutional maintenance of the Committees on Necrology and Resolutions.

Nominations to fellowship resulted in the election of twenty-eight fellows, whose names are listed in the preceding report on the Annual Meeting.

The Council authorized the Treasurer to spend up to $25.00 per year for clerical assistance.

A motion was passed recommending that the Junior Academy consider association with the Science Clubs of America and report to the Council at its next meeting.

The meeting adjourned after a considerable period of semi-formal discussion of various aspects of the work of the Academy which demanded no specific action.

Respectfully submitted,

A. W. LINDSEY, *Secretary.*

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

COLUMBUS, OHIO, April 28, 1944.

To the Ohio Academy of Science:

The annual meeting of the Joint Administrative Board of the Ohio Journal of Science was held at the Ohio State University, April 28, 1944. The meeting was called to order by the Chairman, Dr. Snyder, at 11 A. M. Present were Drs. Snyder and White, representing the Ohio State University; Dr. Evans, representing the Academy, and Drs. Blaydes and Miller, representing the Journal, Dr. Spencer being unable to attend.

The minutes of the preceding meeting were read and approved. A motion presented by Dr. White and seconded by Dr. Evans that Drs. Blaydes and Miller be retained as Editor and Business Manager for the year 1944–45 approved.

The Business Manager's report was given by Dr. Miller. He called the attention of the board to the fact that the $251.02 surplus over 1942 should not be interpreted as indicating as accumulating asset. The cost of printing during the past year has increased by $234.66. It was possible to meet expenses during the past year due to the payment of $497.75 by the Academy for delinquent memberships. The Journal has effected to the limit economies through change in format, size of type, and reduction in number of pages. Further reductions are impractical and would effect no material savings.

The Business Manager wishes to place on record before the Academy the fact that with the increase in cost of production of the Journal additional problems in financing must be faced in the near future.

Drs. Snyder and White were appointed as auditors. A motion by Dr. Evans and seconded by Dr. White that the Business Manager's report be accepted. The motion was carried.

The financial statement follows:

THE OHIO JOURNAL OF SCIENCE—FISCAL YEAR 1943

RECEIPTS

Balance for 1942	$ 215.29
University allowance	750.00
Ohio Academy of Science—pro rata of dues	715.50
Ohio Academy of Science—Proceedings	103.68
Ohio Academy of Science—delinquent membership payment	143.25
Ohio Academy of Science—Balance from 1942	250.00
Subscriptions	111.00
Sale of back numbers	77.36
Author's payment for plates	43.46
Payments by authors and institutions of publication costs	148.75
	$2,558.29
Checks outstanding—O. S. U. Mailing Department	5.01
	$2,563.30

EXPENDITURES

Spahr and Glenn, Printing Vol. 43, and envelopes and stationery	$1,777 18
Bucher Engraving Company	261.50
Postmaster	30 00
O. S. U. Mailing Department	5 01
Bank charges	2 32
Student Auditing Fund	1.00
Clerical assistance	20 00
	$2,096.99
Balance on hand, February 14, 1944 (Huntington National Bank)	466 31
	$2,563 30

The Editor's report was given by Dr. Blaydes. The Editor reports that 44 papers, 28 book reviews and the Academy Proceedings were presented in 277 pages in Volume 43.

The problem of obtaining manuscripts under war conditions was discussed at some length. The Editor is continuing in his effort to obtain special invitation papers.

The Editor wishes to call attention to the board and through the board to the Academy the many difficulties which war conditions have precipitated. He asks that the Academy try to understand that delays in publication, reduced weight and quality of paper are but a few of the editor's war time problems. A motion by Dr Evans and seconded by Dr. White that the Editor's report be accepted. The motion was carried.

A motion presented by Dr. White, seconded by Dr. Evans and passed by the board is as follows: The board desires to extend to the Editor and Business Manager of the Journal its sincere appreciation and approval in perpetuating a commendable publication under the most trying circumstances.

The meeting adjourned at 12:30.

JOHN A. MILLER,
Secretary of the Board.

REPORT OF THE LIBRARY COMMITTEE

COLUMBUS, OHIO, May 4, 1944.

To the Council of the Ohio Academy of Science:

The sales of publications plus sales tax amounted to $13.61. This sum, less 49 cents expended for fifty tax stamps, has been given to the Treasurer. Twenty-three items were sold in seventeen sales. Six were copies of Dr. W. G. Stover's Agaricaceae of Ohio and five of those were sold as a result of the favorable comments made about it by Mr. E. S. Thomas in a Sunday issue of the *Columbus Dispatch* last August.

This is the fourth year that the Ohio Journal of Science has not been sent to foreign countries in the eastern hemisphere and the third year that it has not been mailed to the other Americas. The stock became too large for the storage facilities of the mailing room and as the main building of the Ohio State University library had no place for it, it was all brought over to the Botany and Zoology library where it was assembled into volumes, wrapped, marked, and stored on top of the book stacks. The surplus for each issue is brought and put away in the same manner. The volumes will be posted at the end of the war to the exchanges whose libraries are still in existence.

Two years ago the members of the library committee considered ways to circulate more of the stock of the Annual Reports and special papers of the Academy. Two plans were proposed and the results were to be reported the following year. One plan was to send the price list again to book dealers. This was done and the report was made last year that it has produced no results. The other plan was to make use of the forthcoming new edition of the Union List of Serials in order to ascertain the various numbers of the Proceedings which were lacking in the libraries listed in it and offer to supply them on a sale or an exchange basis as the case might be. As the publication of the Union List was postponed for a year, the report on this plan had to be held over until this year.

Ninety-five libraries in this country and Canada reported their holdings of the Ohio Academy of Science Proceedings in this new edition. Of this number, twenty-five libraries in the United States and two in Canada reported complete sets. Notices were sent to twenty libraries which had more than just a few stray numbers, offering to supply what they lacked if the numbers were still available. So far replies have been received from twelve, with the result that five of them had complete sets without realizing it. This was due to the fact that the name "Proceedings" and the volume numbering did not begin until the twelfth report which Professor J. H. Schaffner marked as volume four, part 1. He assembled the first eleven reports and the first seven special papers into three volumes, and although he was very careful to give a full explanation in the twelfth report, yet quite a number of libraries assume that they lack the first three volumes of the Proceedings. Two libraries reported having complete sets except for one paper, the unavailable Trees of Ohio, by Professor Schaffner. Their sets were completed for three libraries, and for another except for this one paper, so that now the record is that thirty-five libraries in this country and Canada have complete sets and five more lack only the one paper. But not much stock was used as filling in the sets in the four libraries required only ten special papers and forty-three annual reports. Correspondence will be maintained with more of the libraries that are cited in the Union List of Serials.

As a result of the notice published in the November issue of the Ohio Journal of Science that a copy of Professor E. L. Moseley's book on Milk Sickness caused by White Snakeroot would be sent without cost, twelve copies were posted to members of the Academy living in various parts of Ohio and in two other states. Three more members will be supplied later with copies.

One new exchange was secured, another was resumed as publication was begun after a lapse of thirty years, and one of long standing was transferred from the exchange list of the Academy to the subscription list of the Ohio State University library as the organization had found it necessary to curtail the number of its exchanges.

Respectfully submitted,

WARREN P. SPENCER,
WILLIAM LLOYD EVANS,
ETHEL MELSHEIMER MILLER, *Chairman*

REPORT OF THE COMMITTEE ON NECROLOGY

To the Ohio Academy of Science:

Your Committee deeply regrets to report the death of four members of the Academy which have been brought to its attention. The names are those of Dr. Arthur T. Evans, Prof. Ralph A. Schaller, Dr. Adam P. Seyfried, and Dean Alfred Vivian.

ARTHUR T. EVANS—The death of Dr. Arthur T. Evans, Head of the Department of Botany at Miami University, occurred on October 5, 1943, in Oxford, Ohio, after an illness of several months. He was born in Wellington, Illinois, in 1888. He came to Miami University in 1928 from South Dakota State College, where he had been head of the Department of Botany and Plant Pathology since 1920. During the year 1918-1919 he conducted investigations on cereal crop diseases in the Great Plains area for the United States Department of Agriculture. His academic training was received at the universities of Illinois, Colorado, and Chicago. Early experience as a teacher was gained in the Wakefield, Michigan, Township High School, of which he was principal. With the coming of World War II he became actively interested in promoting the development of Victory gardens in the region about Oxford.

The scientific organizations of which Dr. Evans was a member were the American Botanical Society, American Association for the Advancement of Science, Sigma Xi, and Phi Sigma. He joined the Ohio Academy shortly after coming to Miami University and was made a Fellow in 1931

RALPH A. SCHALLER—An active and useful life came to an all too early close in the death of Professor Ralph A. Schaller, of Bowling Green State University, at Bowling Green, Ohio, on February 3, 1944, a few weeks short of his forty-third birthday. In 1940 he had become instructor in biology at Bowling Green and in 1943 he was advanced to the rank of Assistant Professor. His scientific interests were primarily in the field of botany. His early professional life had been largely devoted to high school instruction. In 1931 he received the degree of Master of Arts from the Ohio State University and subsequently continued work toward the doctorate. His high school experience quite naturally developed an interest on his part in the junior division of the Ohio Academy of Science and for a time he was vice-president of the Junior Academy. An active interest in the problems of conservation led to his election to the presidency of the Wood County Natural Resources Council. In addition to being a member of the Academy he belonged to the American Association for the Advancement of Science.

The wide range of Professor Schaller's interests is shown by the fact that he had served two terms on the Bowling Green city council, was leader in his church and had been twice president of the Bowling Green State University Alumni Association.

ADAM P SEYFRIED—Dr. Adam P. Seyfried was Associate Professor of Biology at the University of Dayton. His sudden death in Dayton after a brief illness on August 29, 1941, at the age of 44, brought to an untimely end a career as teacher in the educational institutions of the Society of Mary which had been most successful and gave full promise of even greater usefulness. He was beloved by all who knew him, colleagues, students, and friends alike, for his geniality, kindness and sincerity of character. After graduation from the University of Dayton he taught in California and in Detroit. He then did graduate work at the University of Fribourg, Switzerland, from 1924 to 1928, from which institution he received the degrees of Master of Arts and Doctor of Philosophy. His research was on the anatomy and histology of the myrmicophilous histerid *Chrysetaerius iheringi*. Following a six-year term as pricinpal *of St. James High School in California he joined the faculty of the University of Dayton in 1925.*

Besides membership in the Ohio Academy of Science he held membership in the National Association of Biology Teachers and in the American Association for the Advancement of Science.

ALFRED VIVIAN—In the death of Dean Alfred Vivian, the distinguished Dean Emeritus of the College of Agriculture of the Ohio State University, the University, the Ohio Academy of Science, the state and the nation have lost an outstanding leader in the development of scientific agriculture. He died in Columbus, Ohio, at the age of 76 on October 23, 1943, from a heart ailment after a three-day illness. Those who knew him ever remember his genial nature, those who worked with him will miss his kindly and sound counsel, and those who enjoyed his intimate acquaintance will cherish memories of warm and loyal friendship. Dean Vivian's early scientific interest was in agricultural chemistry in which field he obtained his doctorate at the University of Wisconsin and in which he began his career at the Ohio State University in 1902 as an Assistant Professor. His subsequent work in this phase of chemistry was outstanding and his development of the Department noteworthy. His broad interest in agriculture, his grasp of rural problems, and his keen and enthusiastic appreciation of the possibilities in scientifically conducted agriculture led to his selection as Dean of the College of Agriculture in 1915. *Under his direction this division of the University* reached a position of leadership in the agricultural world. He was a member of numerous scientific organizations and was elected Fellow of the Academy in 1920.

When he gave up his active professional life, Dean Vivian continued his interest in the life of the rural dweller, and of the city dweller as well, by sharing with others his unusually large collection of musical records through the medium of broadcasting station WOSU. Up to the time of his death he planned, supervised, and frequently announced a daily program entitled "World Famous Music," made up of records taken from his library.

Respectfully submitted,

FREDERICK H. KRECKER.

A UNIQUE PREHISTORIC IRRIGATION PROJECT[1]

HENRY C. SHETRONE
Ohio State Archaelogical and Historical Society
Columbus, Ohio

Intentional diversion of water from its natural channels, for the purpose of irrigating regions of inadequate rainfall, is widespread in time and space. Usually, however, it is thought of as something of an innovation and as of more or less local significance.

Inhabitants of humid areas are likely to under-estimate the very considerable portion of the earth's surface where the natural supply of moisture is insufficient to meet the needs of agriculture and other human economic requirements. In the United States alone virtually one-half the land area, westward from its longitudinal center, is arid or semi-arid, as are vast areas in Mexico and South America.

Much of the Old World, particularly those countries adjacent to the Mediterranean and in the Near East, where ancient civilizations originated and flourished, are arid and desert-like. The valleys of the Tigris, the Euphrates and the Nile are classical examples of the dependence of life on the natural or induced overflow of these great river systems.

The importance of water—and the tragedy of too much or too little—are reflected in the early literature, both sacred and profane, from the time of the Babylonian poet-philosophers downward through the centuries. An outstanding record of excessive rainfall is that of the Noachian flood; a minor example may be found today in the rain belt where someone, perhaps with a picnic in prospect, hopes that tomorrow may be fair! In between, the annals of virtually every people contain legends of floods and consequent devastation. Because of insufficient rainfall Moses, leading the Children of Israel back to the homeland, smites the rock, that they may drink; and the Arab sheik bespeaks the compassion of Allah in the matter of the failing desert spring.

The crude methods of conserving water for domestic and agricultural use employed by present-day Pueblo Indians of the arid Southwestern United States are a matter of common knowledge. Natural springs and water holes are seasonal sources; rivers which carry water through the year serve those living adjacent thereto; but by far the greater number of inhabitants must conserve rainfall and storm water from the mountains and the high mesas in natural depressions, converted into reservoirs by means of dams and other artificial modifications. While in some instances ditches lead from these to nearby fields and gardens, the Indian women usually must carry water in jars for hand-irrigation of their meager crops. Archaeological investigation has shown that, with few exceptions, surprisingly similar methods were employed in prehistoric times in the same general area.

This paper, however, is concerned with the historic aspects of irrigation only as a frame or background for an even more romantic phenomenon—prehistoric irrigation in the New World!

Although a matter of record, it is not generally known that in South-central Arizona, long before the discovery of America, the native aborigines had perfected an impressive system of irrigation, which made possible the successful practice of agriculture over a period of several centuries. This system has been referred to as a "million-dollar project, constructed with nothing more than rude stone hoes and wooden digging sticks."

---

[1] Address of the retiring President of the Ohio Academy of Science, delivered at the annual meeting of the Academy held in Columbus, Ohio, May 5, 1944.

Residents of Ohio and adjacent parts of the Middle West, where the civilization of the so-called Mound Builders has been made known through exploration of their ancient tumuli, may not find this so incredible; but to many persons, accustomed to think of all prehistoric peoples as mere savages, the phenomenon is certain to be something of a surprise.

A glance at the map of the southwestern United States will serve to set the stage for the human drama which now unfolds itself. It will be noted that the state of Arizona, youngest of the American commonwealths, is bounded on the north by Utah and Colorado; to the east is New Mexico, and to the south is old Mexico. The great Colorado river, beyond which is California, forms Arizona's western boundary

Traversing the state from northwest to southeast are southern extensions of the Rockies, and the high plateau, where today live the Pueblo Indians and where in ancient times lived their predecessors, the prehistoric Pueblos and the so-called Basket Makers. To the west and south of the mountains is the Arizona desert region of scant rainfall, where, because of its much lower altitude, relatively high temperatures prevail.

In south central Arizona is the city of Phoenix, capital and metropolis of the state. From the mountains and high plateau toward the east come two rivers—the Salt from the northeast and the Gila from the southeast. They converge just west of Phoenix and find their way, as the Gila river, to the Colorado and the Gulf of California.

The State of Ohio sometimes is referred to as the land of the Mound Builders; the valleys of the Salt and the Gila, particularly the region of which Phoenix is the hub, may with equal justification, be referred to as the land of the Canal Builders! Here we have the double phenomenon of an area of considerable extent, by nature arid and uninviting which, for several centuries in prehistoric times, was made to "blossom as the rose", which then reverted to its natural aridity; and now, once again, has become one of the more fertile and productive regions of the continent!

The visitor to Phoenix need walk but a short distance outside the city limits to come upon one or more ancient irrigation canals. Accompanied by a guide familiar with the terrain, he will be able to trace a number of others, and will learn that prior to their partial obliteration by present-day agriculture, some 125 miles of main irrigation canals were existent in the Salt river valley and perhaps half that mileage in the valley of the Gila. Many of these measure as much as 30 feet between their crowns and reach depths of ten feet or more. Even at this late date some of these may be traced for as far as ten miles.

The canal system in the Salt river valley consisted of several independent units, or main canals, each with many branch canals and ditches. Intakes of the main canals were far enough up-stream to provide sufficient "fall" for successfully irrigating their respective areas. The lateral branches, most of which long ago were obliterated through erosion and silting, must have aggregated hundreds of miles.

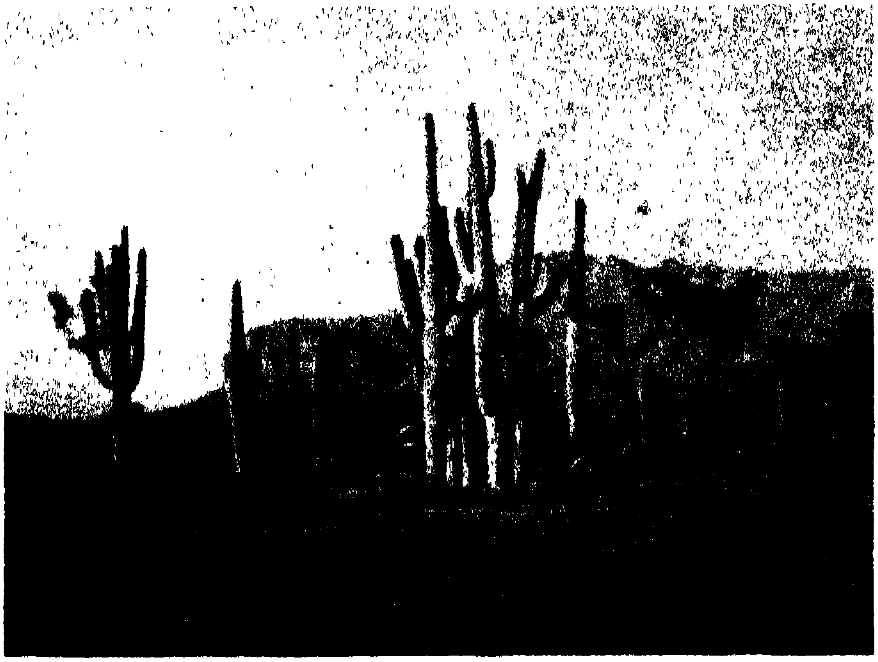
An aerial survey of the valleys of the Salt and the Gila was effected in 1930 through the cooperation of the Smithsonian Institution, the United States Army, and certain authorities in Arizona. This aerial reconnaisance, during which the region was accurately photographed and mapped, was followed by a ground survey under the direction of Phoenix city archaeologist, O. S. Halseth. As a result of this dual survey, what admittedly is the only true irrigation culture in prehistoric America has become a matter of record.

This brief outline of prehistoric irrigation and agriculture in Arizona should elicit a desire on the part of the listener to learn something of the people responsible for their development. Who were the ancient Canal Builders? Spanish paesdr and adventurers from old Mexico, who came into the region toward the close of

the Seventeenth Century, perhaps were the first white men to ask this question. Naturally, they sought the answer from the native Indians, the Pimas, resident in the district, and received the reply, "Ho-ho-kam!" meaning nothing more nor less than "those who have vanished." The canals and the adjacent ruins already were abandoned and ancient as far back as Pima tradition carried.

Thanks to archaeological researches sponsored by the University of Arizona; the City of Phoenix; Gila Pueblo of Globe, Arizona; the Bureau of American Ethnology and other agencies, the erstwhile forgotten annals of the Canal Builders in great part have been recovered and recorded. This is particularly true of the material aspects of their culture.

As indicated by their numerous irrigation canals, the Hohokam peoples were agriculturists. In and adjacent to the Salt river valley there are the ruins of some 20 ancient farming communities, each with its central communal adobe structure, with perhaps half that number in the valley of the Gila. The most impressive of these ruins in the Gila drainage is the noted Casa Grande, now preserved as a national monument.



2. Typical landscape of unirrigated section of Salt River Valley.

Outstanding in the Salt river valley is Pueblo Grande, a part of the park system of the city of Phoenix, located just east of the city limits. Here the enterprising capital city of Arizona has erected an Anthropological Laboratory in which is housed a museum of the Hohokam culture, workrooms and laboratories, accommodations for visiting anthropologists and students, and living quarters for the Director of the Laboratory, who also has the title of City Archaeologist. During the months of February and March, 1944, your speaker had the pleasure of being a guest at the Laboratory, with unusual opportunity for studying the Hohokam culture at first hand.

A brief description of Pueblo Grande ruin and its adjacent farming community will serve as an index to the culture as a whole, which is quite homogeneous throughout the area of its occurrence.

The ruin of the Pueblo Grande community structure, adjacent to the Laboratory, is a more or less rectangular truncated mound of earth and stone, some 150 feet in width and 300 feet in length with an approximate height of 30 feet. It has been partially excavated by Director Halseth and his associates and students, and proved to consist of a large number of rooms or compartments of varying sizes. The walls and partitions are constructed of flat stones and boulders imbedded in adobe clay, with roofs of logs, poles, brush and adobe. Enclosing the structure, and built from similar materials, was a high wall. Entrance to the resulting compound presumably was by means of ladders. The structure and its compound served the community as a granary and storehouse for their corn, beans, squash and other products and possessions, and as a safe retreat from marauding tribesmen from outside their borders. The great size of the structure and its many rooms are accounted for by the fact that adobe construction was at best only temporary or semi-permanent, and required frequent repairs, abandonment of certain parts, and the building of new units.

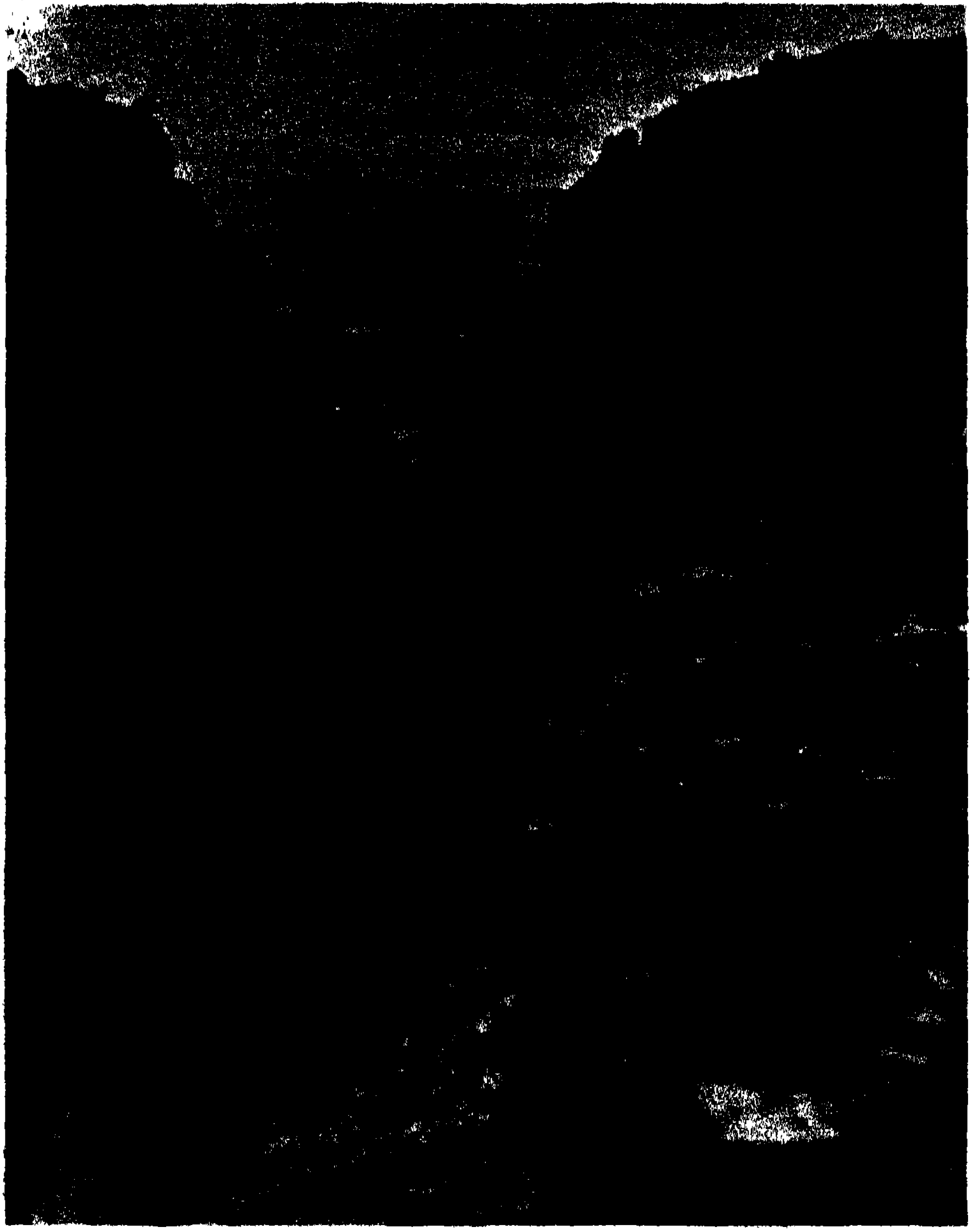
Outside the compound and adjacent thereto were the cultivated fields, comprising many acres. Here too the people lived, their domiciles being merely crude shelters of poles and brush, their floors somewhat below the surface of the ground—a type of domicile known to archaeologists as "pit houses."

It would be unfair to judge the culture of the Hohokam peoples solely by their unassuming dwellings, for it should be remembered that in the mild climate of their country they could be, and were, people of the great outdoors. Their amazing system of irrigation canals and the resulting agricultural development, together with their pretentious communal centers and their ceremonial ball courts, are sufficient to place them on an advanced plane of culture; nor should one overlook their admirable development of the minor domestic arts. While little of a perishable nature has survived the destruction wrought by time and the elements, their utilization of clay, stone, shell and other time-resisting materials, is in keeping with their major accomplishments. The potteryware of the Hohokam, particularly, is exceptional and many fine examples of pots, jars, vases and bowls, of pleasing form and decoration, have been recovered. Equally impressive, if not as artistic, are the numerous metates and manos, for grinding corn and other grains and seeds, while their stone axes are among the finest known. Beads, pendants, bracelets and necklaces of shell and other materials are much in evidence, and turquoise occurs sparingly. Chipped flint projectile points and knives, while often of good workmanship, are much less abundant than in the Middle West, obviously for the reason that the Hohokam were mainly agricultural and only moderately dependent on wild game for food. Tobacco pipes are of very infrequent occurrence, as contrasted with Ohio, where large numbers are found in the ancient mounds and burial sites. Tobacco doubtless was ordinarily smoked as cigarettes.

While archaeologists specializing in the culture are virtually agreed that the Hohokam came into the Salt and Gila valleys at or slightly before the beginning of the Christian era, there is no definite evidence as to their origin. There *is* some evidence of affinity with the lesser-known Mogollon and Coshise cultures to the south, and of contact with the Pueblo peoples to the north, but the full significance of these remains undetermined.

Fortunately, however, the approximate period of their occupancy and the probable time and cause of their disappearance from their homeland in Arizona now are known. The techniques employed in discovering and recording a major part of the story of the Hohokam peoples, after the lapse of centuries, not only is a romance in itself, but is an example of the efficiency of the methods of archaeology as well. Here, briefly, is the story.

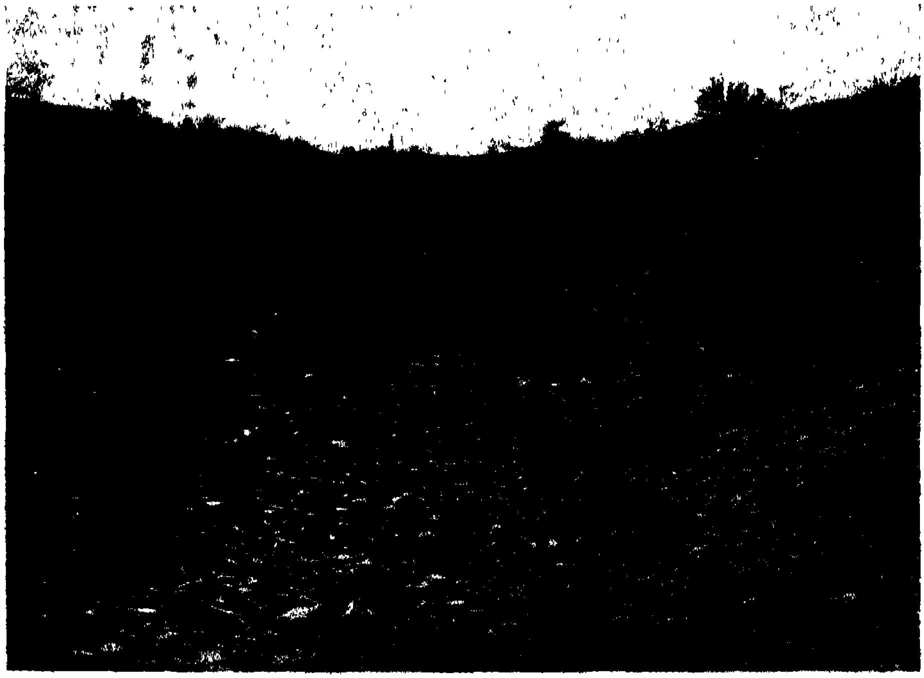
Earlier in this paper it was stated that the Hohokam are believed to have come into south central Arizona around the beginning of the Christian era. At this point it may be stated that they disappeared from the region around 1400 A. D., some three centuries prior to the arrival upon the scene of Spanish explorers and adventurers from old Mexico. For the evidence on which this chronology is



3. View of mountains from Apache Trail, east of Phoenix. Upper course of Salt River, source of irrigation water, seen through the gap.

based, we must turn momentarily to another region and another people—the Pueblo nations of the high plateau and canyons.

Here in a region of evergreen forests, the ancient ruins of the Pueblo peoples actually have been "dated" by means of tree ring counts, a technique developed by Dr. A. E. Douglass of the University of Arizona. Details of this immeasurably important development cannot be given in the limited space of this paper. It is one of the romances of American science. (See bibliography.) Suffice it to say that most of the major ruins and scores of minor ones in the Southwest now have been dated by this method, and that the chronology of the region has been carried back to the First Century A. D.



4. Section of a prehistoric irrigation canal, just east of Phoenix.

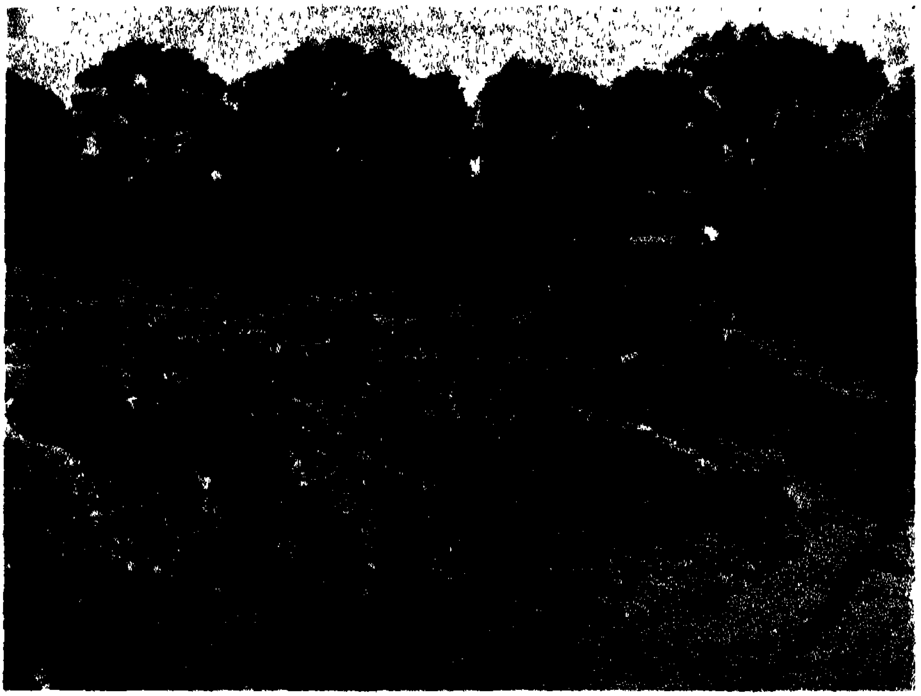
As a result of the tree ring method of dating, those ruins in forested areas adjacent to the Hohokam country show significant changes through the centuries in types and decorations of pottery-ware and in virtually every aspect of their material culture; and since there was more or less of trade and barter as between the two areas, the finding in a Hohokam site of a Pueblo pottery vessel of, let us say, the period of 1000 A. D., is suggestive to say the least. Multiply such individual instances by any reasonable number, and at least a near-contemporaneity is the result. Although the Hohokam country is virtually lacking in large trees, through such analogy and comparison its ruins are dated.

Finally, when all evidence of Hohokam activity ceases, and no further objects known to pertain to other cultures appear in their ruins, it is logical to assume that their career as a people was ended. Such conditions are found to obtain not much later than 1400 A. D.

The disappearance of so advanced a people from a region which they had converted into an admirable place of residence was due to two major causes. One of these is disclosed in a brief consideration of the present-day situation.

In the 1870's Mormon settlers appeared in the Salt river valley and began clearing out ancient irrigation canals and constructing others. In the ensuing years this initial enterprise has grown by leaps and bounds, with some 400 square miles of terrain, requiring annually 1,000,000 acre-feet of irrigation water, now under cultivation. Thus the land of the ancient Canal Builders once more has come into its own, and the Salt river valley—the Valley of the Sun—with its great citrus groves, date orchards, farms which produce as many as three crops annually, and sub-tropical plants and flowers growing in great profusion, is indeed an oasis in the desert.

In view of the fact that this transformation is due entirely to irrigation, it may appear contradictory to suggest that irrigation was the principal cause of the downfall of the Hohokam peoples. The Salt river valley is underlaid with a "volcanic pocket" of clay or marl which is virtually impervious to water. According to estimates of the Salt River Waters Users Association, one-fifth of the total irrigation water enters the ground as seepage, and builds up the water table at the rate of from three to five inches each year. During the period from 1870 to 1920, when irrigation was much less intensive, one-third of the area under irrigation was rendered unfit for cultivation as a result of accumulated seepage and attendant alkalinity. Under present-day intensive irrigation, the entire area, within a comparatively short time, would be little short of an alkaline bog. This threat now is averted by periodic flooding to eliminate alkali and by using a battery of electric pumps for the purpose of removing surplus water—some 300,000 acre feet annually.



5. Small section of Casa Grande ruins, partly explored.

The ancients had no drainage facilities, pumps or otherwise. The result was inevitable; surplus water and alkalinity, water-logged soil, and dwindling productivity. This is evidenced by the fact that exploration of the Pueblo Grande ruin demonstrated that the floors of granaries and store-rooms had repeatedly been elevated in an effort to keep them above the water-logged surface of the ground.

An additional situation, which may have been the *coup de grace* of Hohokam survival, was the constant threat from marauding nomadic tribesmen from the plateau areas. It is known that from early historic times the agricultural peoples of the valleys were frequently raided by the Navajo, the Apache and other predators who made bold to reap where they had not sown, and there can be but little doubt that the peaceful Hohokam peoples, throughout their sojourn in their chosen country, were forced to contend with similar hostile incursions. Faced by such handicap, and seeing their once fertile acres gradually transformed into water-logged and alkaline wastes, it was inevitable that their numbers must decline to the point where a few hungry stragglers either found refuge with other tribes or passed entirely from the picture.

Today there remain only the old canals and the ruins of once impressive communal structures—mute evidences of a people who had carried the human experiment, through trial and error, to a level which must command the admiration of all discerning men; a people who, but for a natural calamity with which they could note cope, and because of the rapacity of unscrupulous and hostile neighbors, might have borne the torch of civilization to undreamed-of heights The construction of a million dollar irrigation system, representing a high degree of engineering skill, attests to their energy, strength, courage and initiative.

Our culture of today is complex, while theirs was simple; but who would venture to say that ours is "higher" or better? We, as were they, are still beset with the threat of natural calamity, and by "man's inhumanity to man." The first of these is nothing as compared to the latter, which now has precipitated all mankind into a holocaust such as the world never has known, the aftermath of which conceivably might be more disastrous than the titanic struggle itself.

The only criterion which justifies an assumption that one culture is higher or better than another, is proof that it provides a larger measure of cooperation, usefulness, spirituality, morality—and human happiness!

A BRIEF BIBLIOGRAPHY

Irrigation.
General:
Newell, Frederick H. *Irrigation in the United States.* New York, 1902.
Arizona:
Halseth, Odd S. *Prehistoric Irrigation in Central Arizona* The Masterkey, Los Angeles, 1932.
Halseth, Odd S. *Prehistoric Irrigation in the Salt River Valley.* Bulletin 296, Univ. of New Mexico, 1936.
Schroeder, Albert H. *Prehistoric Canals in the Salt River Valley, Arizona.* American Antiquity, Vol. VIII, April, 1943.
Tree Ring Dating:
Douglass, A. E. *Tree Rings and Chronology,* Bulletin, Vol. VIII, No. 4, Univ. of Arizona, 1937.
Douglass, A. E. *Southwestern Dated Ruins,* V, Tree Ring Bulletin, Vol. V, No. 2, 1938.
Hohokam Culture:
McGregor, John C. *Southwestern Archaeology,* New York, 1941.
Various authors in *Medallion Papers,* Globe, Ariz.
Southwestern Archaeology:
Kidder, Alfred V. *An Introduction to the Study of Southwestern Archaeology.* Andover, Mass., 1924.
McGregor, John C. *Southwestern Archaeology.* New York, 1941.

For Earlier References, see *Handbook of American Indians,* Bureau of American Ethnology Bulletin, Washington, 1910.

THE RESEARCH FUND OF THE OHIO ACADEMY OF SCIENCE

HERBERT OSBORN
The Ohio State University
Columbus, Ohio

The special research fund of the Academy was inaugurated by an initial donation from Mr. Emerson McMillin at the Academy meeting of 1898 and his contributions were continued until his death in 1922, at which time there had been accumulated under the careful management of Dr. Mendenhall a balance of over $1,300 00 which was invested and the income from which has in part been used in grants during the later years.

A record of the grants made during the passing years, now nearly a half century, would seem to be a worth-while effort and since the writer has had some connection with the use of the fund during many of these years, it seems appropriate to undertake the task, especially as it was his privilege to collect some data in this connection at the time of the celebration of the half century of Academy history.

That a small grant such as was possible with the initial $250.00 can be made to secure large results is, I think, demonstrated by the record and it may be said that these grants have had the effect of not only furnishing the needed assistance in the provisions for travel expenses or the apparatus for various investigations, but have been a very effective stimulus toward the undertaking of research problems which might otherwise have been neglected. Certainly in many cases the grants have been the means of providing opportunity to teachers or students who could afford the time but lacked certain facilities to pursue investigations for which they were well qualified but lacked the means to finance them from their individual resources. That the fund has had the effect of encouraging research work on the part of some who would not have been attracted to it is, I think, also evident.

In this summary review of the projects assisted by the fund it may be of interest to note that the very first grant, which was to Prof. W. G. Tight, of Denison University; J A. Bownocker, of Ohio State University, and Dr. J. H. Todd, of Wooster, was for a distinctly Ohio problem, the Preglacial Drainage of Ohio, and quite naturally the great majority of the projects assisted have been of a state character relating largely to the geology and biology, utilizing local talent for the study of local problems which often have world-wide significance.

For the Fifty Year Celebration the writer brought together a preliminary list of the grants, the persons receiving them and subjects of the investigations which were submitted to the committee on history, but naturally with the large amount of material accumulated for that event there could be little place for this record and no extended publication of the data has been given aside from the list of "Grants from the Research Fund," appearing in an article by historian W. H. Alexander, *Ohio Journal of Science*, Vol. 41, p. 304. That list is lacking in some details and might be misunderstood since grants listed as allotted were in some cases not used and in others the project delayed and the actual payment made in a subsequent year. Also no record is made of the subjects of the various projects which might be of interest to those who care to look into the distribution of the fund. The amounts noted in that list give substantially the distributions made from the McMillin donations and need not be repeated. They amounted to over $6,000.00 in all and may be treated separately from the grants allotted by the A. A. A. S. in recent years and considered in a separate paragraph. Also as noted in a quotation from the by-laws, certain items such as life membership, donations and sale of publications are to be placed in the research fund and income only used for grants in aid of research. (See paragraphs from by-laws below.) See also Report of Trustees, April 30, 1932, in Proc. Ohio Acad. Sci., *Ohio J. Sci.*, 32: 280–1. A. A. A. S., 1930

The first Board, 1898, consisted of F. M. Webster, W R. Lazenby, E. L. Moseley, *vide*, p. 13, 7th Annual Report.

Grants as made by years were as follows:

1899. The first grants made from this fund in 1899 went to W. G. Tight, Preglacial Drainage of Muskingum Valley; J. A. Bownocker, Preglacial Drainage of Miami Valley; J. H. Todd, Preglacial Drainage in Wayne County; R. C. Osburn, Fishes of Northern and Southern Ohio, with later allotment for printing the Preglacial papers.

1900. To Gerard Fowke, Preglacial Drainage, Cincinnati; R. C. Osburn, for continuance of Fishes of Ohio; T. A. Bonser, Flora of Big Spring Prairie; Prof. J. S. Hine, Insects of Certain Parts of Ohio.

1902. J. S. Hine, Tabanidae of Ohio, two grants, published in Special Papers No. 5. Lynds Jones, "Birds of Ohio," two grants, published as Special Paper No. 6. F. L. Landacre was given two grants for studies on Protozoa, later published as Special Paper No. 13. Max Morse, grant for study of Batrachians and Reptiles of Ohio, and expense of publication, Special Paper No. 9. J. H. Schaffner, Ecological Study of Brush Lake, Special Paper No. 10.

1903. T. A. Bonser, Flora of Big Spring Prairie, published as Special Paper No. 7, "Ecological Study of Big Spring Prairie."

1904. F. L. Landacre, Studies on Protozoa, two grants Max Morse, Reptiles of Ohio, Special Paper No. 9. J. G. Sanders, Coccidae of Ohio, published as Special Paper No. 8. Several small grants for Ecological Study of Brush Lake by J H. Schaffner.

1905. R. F. Griggs, "Willows of Ohio, Special Papers No. 11. Herbert Osborn, two grants for "Study of Insects of Ohio," published in articles appearing in 8th Annual Report, *Ohio Naturalist* and Bulletins of Ohio Biological Survey.

1906. W. B. Herms, Relations of Insects to Organic Debris on Lake Beaches. J. E. Hyde, Upper Waverly Formation in Central Ohio. F. Carney, Local Glacial Geology Near Granville. Chas Brookover, Fiber Tracts and Neurones of *Amia calva*. Victor Sterki, Land and Fresh Water Mollusca, Special Paper No. 12.

1907. W. C. Morse, for "Studies on Maxville Limestone," published as Special Paper No. 17, Fauna of the Maxville Limestone.

1908. A. Dachnowski, Peat Bogs in Ohio. H. S. Hammond, Mosses and Liverworts in Ohio. S. Morgulis, "Regeneration in Plants." L. B. Walton, "Naididae of Ohio." Freda M. Bachman, Special Papers No. 14, "Discomycetes in the Vicinity of Oxford," "published by the McMillin Fund." G. E. Goghill, "Breeding Opossum in Pens under Controls to Secure Embryos," published in *Ohio Journal of Science*, Vol. 39, pp. 239–249.

1909. J. H. Schaffner, "Trees of Ohio and Surrounding Territory," published as Special Papers No. 15. Walton, "Fresh Water Oligochaetes of Ohio," and Freda Detmers, "On the Genus Carex." A. Dachnowski, "Peat Bogs of Ohio." G. E. Coghill, "Opossum," and R. J. Sim, "Nesting of Birds in Northeastern Ohio."

1910. J. H. Schaffner, "Pteridophytes of Ohio," for publication, Special Papers No. 16.

1911. W. C. Morse, "Fauna of Maxville Limestone," Special Paper No. 17. W. M. Barrows; A. Dachnowski, "Peat Bogs of Ohio," published in Bulletin 16, Ohio Geological Survey as "Peat Deposits of Ohio," also in *Bot. Gazette*.

1912. W. G. Stover, "The Agaricaceae of Ohio," Special Paper No. 18. "Ecological Study of Buckeye Lake," by Freda Detmers, Special Papers No. 19. L. B. Walton, "Fresh Water Oligochaetes." J. S. Hine, "Mammals." A. Dachnowski, "Peat Bogs of Ohio" (see above). W. J. Kostir, "Orthoptera of Ohio."

1915. R. F. Griggs, Plant Ecology in Ohio. L. B. Walton, Fresh Water Organisms. W. H. Bucher, Related Localities of Wavy Sedimentary Strata. J. S. Hine, Collecting Insects in Northeastern Ohio. S. R. Williams, Richmond Deposit in Butler County.

1916. Williams and Shideler, "Richmond Division of Ordovician." L. S. Hopkins; B. W. Wells, Zoocecidia on *Celtis occidentalis*. F. L. Landacre, for set of eggs of Marine lamprey *Petromyzon* to study origin of cerebral ganglion.

1917. Forrest B. H. Brown, Determining main forest types in Ohio. S. R. Williams, Geology in Southwestern Ohio. W. M. Barrows, Effect of radium on germ plasm.

1918. G. D. Hubbard, Geography of Columbus region. E. L. Rice, Chondrocranium of Eumeces. L. B. Walton, aquatic organisms. E. N. Transeau; H. W. Lutz, "Root Rots of Apples."

1919. J. S. Hine, Ohio Mammals; see Proc. Ohio Acad. Sci., Vol. 8, Part 6, 1929. W. H. Bucher, Geology of Adams County. L. C. Hopkins, Collection of Pteridophytes.

1920. F. C. Blake, two grants for purchase of apparatus. Paul B. Sears, *Ohio Vegetation*. W. H. Bucher; L. B. Walton, Fresh Water Organisms. Elsie Jordan, continued in '21.

1921. Elsie Jordan, "Relabeling Harper Collection of Naiades" under Dr. Bucher. L. B. Walton, study of "Fresh Water Organisms," published as Ohio Biological Survey Bulletin No. 24, "Fresh Water Organisms in Water Supplies."

1922. Paul B. Sears, "Vegetation of Ohio" J S. Hine, "Mammals of Ohio."

1923. L. B. Walton, Aquatic Organisms. F. H. Herrick, Eagle Nests at Vermillion, Ohio. L H. Tiffany, collecting algae in Ohio. J. E. Kindred, aquatic studies in Puget Sound. E. L Stover, underground parts of grasses R. A. Dobbins, mosaic diseases of tomatoes. S. S Humphrey, root and stem rots of clover.

1926. W. M. Barrows, for "publication of paper on structures of spiders."

1928. Bernard S. Meyer, "Study of Seasonal Variation in Leaves."

1934. W. L. Evans for Chemistry Dept., O. S U , for apparatus.

1935. R. B. Frost, Lorain Urban Survey

1936. J. P. Porter, Studies on Behavior of Spiders.

1937 D. C. Rife, Genetic Studies of Monozygotic Twins and other Multiple Births. Wayne M. Felts, On Acid Intrusive in Cascade Mountains of S. W. Washington R. A Dobbins, Vegetation of the Northern Virginia Military Lands of Ohio.

1938. G. D Hubbard, "Abandoned Glacial Lakes in N Ohio" F H. Verhoek, Apparatus for Studies of Solvents

1939. Grant to Dr E. Lucy Braun, University of Cincinnati, for her research upon the Deciduous Forest Formation of Eastern United States. Largely spent in travel expenses. Grant to Bertil G. Anderson, Western Reserve University, Cleveland, Ohio, for construction of constant temperature chamber for various experiments, as for instance, duration of the embryonic period, duration of the instars, etc. Grant to Dr C. A. Lawson, Wittenberg College, Springfield, Ohio, for research defined as "An attempt to determine mechanism of gene action in embryonic development, using the Aphid *Macrosiphum solanifolii*"

1940. Dr. John W. Frink, 424 Riddle Road, Cincinnati, Ohio, for research on the "Terraces of the Ohio River." Grant to Prof. Archie N. Solberg, Biological Laboratory, University of Toledo, Toledo, Ohio, of $50.00 for the making of slides for special work in his research, embryology of *Fundulus heteroclitus*.

1941. J. N. Wolfe, R. T. Wareham and H. T. Scofield, in 1941, with an additional grant later in 1941, for research defined as "Investigation of plant communities and measurement of microclimatic and edaphic conditions in a single valley in Hocking County, Ohio." The money was used for traveling expenses, photographic supplies and materials and tools for the construction of minor equipment. Drs. Wolfe, Wareham and Scofield are instructors in the Department of Botany, O. S. U. Continued in 1942 and 1943

1942. Continued grant to Drs. Wolfe, Wareham and Scofield from A. A. A. S.

1943. B. S. Meyer, Mineral Nutrition of Russian Dandelion. Carl Venard, Mosquitoes of Ohio. Continuation of grant to Drs. Wolfe, Wareham and Scofield.

1944. Continuation of grants to B. S. Meyer and Carl Venard from A. A. A. S. Miss Alta Schrock, Oberlin, Pollen Content of Peat Bogs. Mr. Albert E. Hyder, Ecology of Bird Population in Hocking County. Dr. H. T. Gier, Athens, Reproductive cycles in foxes in southeastern Ohio.

The fund was designated as the Emerson McMillin Research Fund in earlier reports, and may have had an official designation later, but I have not located the record.

No payments on grants were made for the year 1914, 1924, 1925, 1927, 1929, 1930, 1931, and 1933. In some cases at least grants were made but the projects were not completed and the grants lapsed or were continued and paid in later years.

An allowance from the A. A. A. S. based on the members of the Academy who are also members of the A. A. A. S. has been received since 1930, and since 1937 this allowance has been allotted for research projects approved by the Trustees of the Research Fund, the A. A. A. S. specifying that such projects be approved also by their permanent secretary and the amounts expended within the year.

Projects which have been assisted from this source have been as follows. The subjects are listed above.

1937. Dr. D. C. Rife, Wayne M. Felts, R. A. Dobbins.
1938. Dr. G. D. Hubbard, Frank Verhoek.
1939. Dr. E. Lucy Braun.
1940. John W. Frink, Archie A. Solberg.
1941. Drs. J. N. Wolfe, H. T. Scofield, R. T. Wareham.
1942. Drs. Wolfe, Scofield and Wareham.
1943. Drs. Wolfe, Scofield and Wareham. Dr. B. S. Meyer. Dr. Carl Venard.

REGULATIONS FOR THE USE OF THE McMILLIN RESEARCH FUND

The McMillin Research Fund of the Ohio Academy of Science has been maintained through the generosity of Emerson McMillin and grants from this fund are made upon application to the Trustees of the Fund.

Applications for grants should include a statement of the subject to be investigated, the nature of the expenses to be covered, and in so far as practicable a list of the proposed items of expense in such a manner that the Trustees may determine the expenses and the allowance needed.

In rendering accounts it is desirable that an itemized statement be submitted showing the cost of apparatus or supplies used or, in case of traveling expenses, the localities visited, amounts of railroad fare, hotel and other expenses as incurred. Payments granted from this fund will, as a rule, be made only after the expenses have been incurred and upon receipt of detailed statement.

Apparatus, books, maps or material supplies not consumed during these investigations which may be secured with grants from this fund are to be the property of the Academy and after the investigation is completed should be accounted for to the Trustees or deposited with such officer of the Academy as the Trustees may direct.

It is expected that the results of such investigations will be published and if other means of publication are not available, the Trustees will try to assist in securing suitable publication.

.................................., *Chairman.*

The above is a statement of form for application, not followed rigidly. It was prepared I think by Dr. Mendenhall and was formally adopted by the Academy at the 28th Annual Meeting, May 30, 1918.

From Dr. Mendenhall's paper on McMillin read at the Ohio Academy meeting at Oberlin, March 31, 1923, he quotes McMillin:

"The research fund seems to have been pretty lively and doing work out of proportion to its size. The workers rather than the cash, probably are entitled to the credit."

Again: "The Academy needs to live centuries. I cannot, at most, live but a few years, much as I would like to be permanently established at Darlington."

From "Report of the Trustees of the Research Fund," Columbus, Ohio, April 1, 1925:

"We recommend that the income from $1,000.00 of the Research Fund be available each year for a grant to be known as the McMillin grant and which may be used either for the assistance in some research problem or given as an award in recognition of some especially noteworthy contribution of some member of the Academy. That the balance of the Fund and income derived from it, shall be used or allowed to accumulate as the trustees may deem best in any particular year, it being understood that the Fund or any interest income shall in all cases be used for the encouragement of research either by grants for individual problems or for the publication of papers resulting from research."

From the By-Laws adopted at the Thirty-fifth Annual Meeting:

"CHAPTER VII—RESEARCH FUND

"1. *Sources of Fund.*—The Research Fund shall consist of moneys paid by the general public for publications of the Academy, of donations made in the aid of research, and of sums paid in commutation of dues according to By-Laws, Chapter I, Paragraph 1.

"2. *Donors.*—Donors to this fund, to the sum of twenty-five dollars or more, shall be entitled without charge, to publications subsequently appearing.

"3. *Endowment.*—The aim of the Academy shall be to accumulate a fund of which the income alone shall be used for the encouragement of research and for the publication of papers bearing upon the development of science in the state."

TRUSTEES OF RESEARCH FUND AND DATES OF SERVICE

E. L. Moseley	1899–1900	T. C. Mendenhall	1916–1924
F. M. Webster	1899–1904	(Chairman 1916–1924)	
(Chairman 1900–1901)		Herbert Osborn	1917–date
H. C. Beardslee	1900–1902	(Chairman 1925–)	
C. J. Herrick	1904–1906	M. E. Stickney	1917–1919
J. H. Schaffner	1900–1905	G. D. Hubbard	1919–1931, and 1934–1937
W. R Lazenby	1899 and 1901–1916	E. L. Rice	1924–1930
(Chairman 1901–1915)		L. B. Walton	1930–1933
G. B. Halsted	1905–1908	Alpheus Smith	1934–1936
Chas. Dury	1907–1908	W. L. Evans	1937–1939
E. L. Rice	1908–1914	J. P. Porter	1937–1940
Frank Carney	1910–1913	C. G. Shatzer	1939–1942
M. M. Metcalf	1913–1917	Paul B. Sears	1941–1944
N. M. Fenneman	1914–1917	F. C. Blake	1942–1945

The Trustees named at the annual meeting, 1898, for the succeeding year were E. L. Moseley, F. M. Webster and W. R. Lazenby and were for *one year*. In 1899 members were named for one, two, and three years and F. M. Webster became chairman. He was chairman until 1901; W. R. Lazenby, 1901-1915; T. C. Mendenhall, 1916-1924; Herbert Osborn, 1925- .

The following papers published as special papers received assistance from the Research Fund. Special papers from three to nineteen were assisted by grants from Research Fund.

The Preglacial Drainage of Ohio—W. G. Tight, J. A. Bownocker, J. H. Todd and Gerard Fowke.
The Fishes of Ohio—Raymond Osburn.
Tabanidae of Ohio—James S. Hine.
Birds of Ohio—Lynds Jones.
Ecological Study of Big Spring Prairie—Thomas A. Bonser.
The Coccidae of Ohio—James G. Sanders.
Batrachians and Reptiles of Ohio—Max Morse.
Ecological Study of Brush Lake—J. H. Schaffner, Otto E Jennings, Fred J. Tyler.
The Willows of Ohio—Robert F. Griggs.
Land and Fresh-Water Mollusca of Ohio—V. Sterki.
The Protozoa of Sandusky Bay and Vicinity—F. L. Landacre.
Discomycetes in the Vicinity of Oxford—Freda M. Bachman.
Trees of Ohio and Surrounding Territory—John H. Schaffner.
The Pteridophytes of Ohio—John H. Schaffner.

The Fauna of the Maxville Limestone—W. C. Morse.
The Agaricaceae of Ohio—W. G. Stover.
An Ecological Study of Buckeye Lake—Frederica Detmers.

The series of Special Papers was discontinued in 1929, but results of researches under these grants have appeared in the *Ohio Journal of Science*, The Ohio Biological Survey and in various other scientific journals.

I am indebted to Mrs. Ethel Melsheimer Miller for assistance in determining the subjects of researches for a number of the earlier projects.

If details were available an interesting story could be written about the grants that were made but for which no payments were made, due doubtless to the abandonment of the project or lack of reports.

Evolution of Man

This is the fifth title in a series of scientific books sponsored by the American Museum of Natural History. Professor Howells has done a magnificent job of bringing to the layman a highly readable account of the history of mankind. His free and easy style, and the dramatic treatment of the subject matter combine to make this book fascinating in all its details as well as its being authoritative.

There are twenty-five chapters which are organized into three parts. Part One leads the reader through a short discussion of the principles of evolution. Application of these principles are then made to the evolution of the vertebrate groups which have served as ancestral to man. In the second part the author discusses fossil men and their probable relationship to *Homo sapiens*. Enough history about these finds and the men who made them is included to heighten interest in this section. Part Three deals with the nature and origin of races, their migrations and geographical distribution. In the last chapter the author depicts some of the probable trends in man's evolution during the next one million years.—*W. M. Tidd.*

Mankind So Far, by William Howells, xii and 319 pages. Thirty-seven line-cut and half-tone illustrations. Published by Doubleday, Doran and Company, Inc., Garden City, New York, 1944. $4.50.

Ticks of North America

This excellent monograph on argasid ticks contains the following sections: Introduction; Medical and Veterinary Importance of the Argasidae; Explanation of Terms; Principal Characters of Argasidae; Methods; Family Argasidae; Genus Argas; Genus Otobius; Genus Ornithodoros; Genus Antricola; Plates; Classified List of Hosts; Geographical Districution of Species; Bibliography; and Index.

The morphology of each species is thoroughly described and illustrated for all stages that have been recognized. The known distribution of each species is indicated by a map and information on hosts and biology is included in so far as it is available. The numerous illustrations are of high quality in that they are artistic in appearance and show diagnostic features.

Twenty-five species are recognized for the area covered and many people are already acquainted with some of them. Two bad pests are the blue bug of poultry in Florida, Texas and elsewhere, and the spinose ear tick of cattle in the West. Some species are vectors of disease and in this connection may be mentioned the relapsing fevers of the Western States and the experimental transmission of Rocky Mountain spotted fever.

The authors have produced a treatise which can be used by amateurs as well as by seasoned entomologists and therefore it can be predicted that their book will be the stimulus for much research and especially faunistic studies.

The American Midland Naturalist Monograph No. 1. The Argasidae of North America, Central America, and Cuba, by R. A. Cooley and G. M. Kohls. 152 pages, 57 text figures, 14 plates. The University Press, Notre Dame, Indiana, June, 1944. Price, $2.00.

DOLOMITES

WILBER STOUT
Geological Survey of Ohio, Columbus, Ohio

ABSTRACT

The origin of dolomite is a subject of much interest in Ohio as this state is underlain by great thicknesses of such rock, some of high purity. Within the last few years over 335 detailed analyses have been made. These analyses have been reduced by calculation to their mineral components, which treatment throws much light on the nature of the rocks and reveals certain inferences concerning the origin of both dolomite and limestone. From these studies dolomite was deposited in sea water with normal salinity and limestone in that diluted by fresh water from the land areas.

CONTENTS

	PAGE
ABSTRACT	219
INTRODUCTION	219
CHEMICAL NATURE OF CARBONATES	220
SOURCE OF COMPONENTS	221
DATA FROM OHIO	223
FRESH-WATER LIMESTONES OF PENNSYLVANIAN AND PERMIAN SYSTEMS	223
MARINE LIMESTONE OF THE PENNSYLVANIAN SYSTEM	223
MAXVILLE FORMATION	225
DELAWARE FORMATION	225
COLUMBUS FORMATION, UPPER PART	226
COLUMBUS FORMATION, LOWER PART	226
LUCAS FORMATION	229
AMHERSTBURG FORMATION	229
MONROE FORMATION	229
GUELPH-CEDARVILLE FORMATION	230
SPRINGFIELD-WEST UNION FORMATION	230
EUPHEMIA FORMATION	231
LAUREL FORMATION	231
DAYTON FORMATION	231
BRASSFIELD FORMATION	231
ELKHORN OR RED MEDINA FORMATION	232
RICHMOND, MAYSVILLE AND EDEN FORMATIONS	232
UTICA FORMATION	233
TRENTON AND BLACK RIVER FORMATIONS	233
LOWER ORDOVICIAN AND CAMBRIAN SYSTEMS	234
CONCLUSIONS	234

INTRODUCTION

The groundwork for the following paper is as follows:

(a) The examination of a thick section of carbonate rocks in Ohio, Cambrian to Permian time.

(b) Much detailed work in identifying, sectioning and sampling the deposits.

(c) Careful appraisal of mineral components of over 400 high-grade chemical analyses of dolomites and limestones throughout the section.

(d) Use of some of the common chemical reactions involving carbonates.

(e) The aid of a few of the simple laws of thermo-chemistry.

(f) The chemistry of fresh and salt water as defined by Clark.

(g) The fact that the ocean is the only source for such a large supply of magnesium oxide, MgO, or rather atomic magnesium, Mg, in an active form as shown by Clark.

Some of the generalizations considered are as follows: Dolomites are the normal and most abundant deposits of carbonate rocks laid down in the ocean throughout the geological ages. In the limestones this compound, $CaMg(CO_3)_2$, also bears a rather conspicuous part. Many dolomites approach chemical purity, that is, they contain no or little limestone. Conversely the limestones are always more or less dolomitic in character. A detailed physical and chemical study of such rocks in Ohio[1] indicates that the dolomites are primary in origin, that is, they were deposited as found today. No alterations are apparent except very locally and then the change is more physical than chemical. Dolomites originated through chemical activity in sea water of normal concentration, either in shallow or deep water but largely under the former condition.

---

[1] See Bull. 42, Geological Survey of Ohio, also records in files.

On the other hand, limestones, the less abundant carbonate rocks of the ocean, were deposited under marine conditions but where the normal salt solutions were somewhat diluted through the influx of fresh water from land sources. Thus limestones carrying a high content of calcium carbonate are usually in association with shale deposits, either above or below or within the formation. In general the shale materials originated on the land and were carried to the ocean by streams. The streams not only diluted the sea water but brought in large supplies of carbonic acid, CO_2 or H_2CO_3 and some soluble calcium bicarbonate salt, $Ca(HCO_3)_2$. In the great carbonate formations of the Mississippian, Devonian, Silurian, and Ordovician systems the limestone deposits are, with few exceptions, placed between shales. Further, the basal portion of such limestones, if thick, is much higher in dolomitic matter than the upper portion. In the Pennsylvanian and Permian systems in Ohio the carbonate strata of fresh water origin[2] and also those of marine derivation[3] are limestones with a low content of dolomites, $CaMg(CO_3)_2$. The fresh water limestones occur under, and the marine limestones over the coal beds which are known to have been deposited on land through humid conditions. Clays, shales, and sandstones are found as associate deposits. Such limestones, in the coal formations, are usually thin but widely spread in distribution.[4]

CHEMICAL NATURE OF CARBONATES

The carbonate rocks are built around the carbon atom, C, as the nucleus of the acid component. Through oxidation this carbon, C, changes to the oxide form, carbon monoxide, CO, or the dioxide, CO_2, most commonly the latter. Then through hydration, or the addition of water, carbon dioxide, CO_2, produces the unstable acid, H_2CO_3, and the acid salts of $H_2(HCO_3)_2$, as $Ca(HCO_3)_2$, $Fe(HCO_3)_2$, $Mg(HCO_3)_2$, $Mn(HCO_3)_2$, all soluble substances and carried in fresh waters. The changes may be given as follows:

$$\begin{array}{lll} C & & \\ \downarrow & & \\ C+O_2= & CO_2 & \\ & \downarrow & \\ & CO_2+H_2O=H_2CO_3 \text{ or } H_2(HCO_3)_2 & \end{array}$$

Carbon is one of the original elements and in some form is widely distributed in nature. In this discussion carbon dioxide, CO_2, is the compound of most interest. At present, and in the past, most of the carbon dioxide in the air and in solution in fresh or saline waters is derived directly or indirectly from the decay or from the exhalation of organic matter, animal or vegetable, on the land surface, in fresh water or in the ocean. Those of most concern are the parts held in solution in both the fresh waters of the land areas and in the saline waters of the sea. Thus all the streams are pouring continuous supplies of carbon dioxide in some form into the ocean and the sea with the changing of its myriad organic forms, through life and death, generates large amounts for chemical activity. In such ways carbon dioxide has been produced in greater or lesser quantities throughout the geological ages since life began, even in its most simple forms. Hence organic life appears to supply the needed quantity of carbon dioxide to complete the reactions for the precipitation of dolomites and limestones.

---

[2] The fresh water limestones include the Salem, Lower Freeport, Upper Freeport, Mahoning, Bloomfield, Ewing, Elk Lick, Clarksburg, Summerfield, Pittsburgh, Redstone, Fishpot, Benwood, Arnoldsburg, Uniontown, Waynesburg, Elm Grove, Lower Washington, Middle Washington, Upper Washington, Nineveh and Gilmore members.

[3] The marine strata include Lowellville, Boggs, Lower Mercer, Upper Mercer, Putnam Hill, Zaleski, Vanport, Hamden, Brush Creek, Cambridge, Portersville, Ames, Gaysport and Skelley members.

[4] For the relations of coal, clay, fresh water and marine limestones, see Bull. 26, Fourth Series, Geological Survey of Ohio, pages 533-568.

SOURCE OF COMPONENTS

The basic components, MgO or CaO or Mg and Ca, were supplied by the ocean with some augmentation from the land areas. Sea water even after the extraction of large quantities of magnesium for the formation of dolomites throughout the geological ages is still rich in that substance. According to Clarke[5] the salinity of the ocean varies from 3.301 to 3.737 per cent and the mean of seventy-seven analyses is as follows:

Cl.	55 292
Br.	188
SO_4	7 692
CO_3	.207
Na	30 593
K	1 106
Ca	1 197
Mg	3 725
Total	100 000

Thus the quantity of magnesium is over 3.11 times that of the calcium and the reacting value of the former is 5.13 times that of the latter. Hence in any reaction in normal sea water, involving precipitation, magnesium will be the dominating component and dolomite and not limestone will be the resulting product.

Clarke states:[6] "In chemical character, fresh and salt waters are opposites, as a brief inspection of the data will show. In ocean water, $Cl > SO_4 > CO_3$; in average river water, $CO_3 > SO_4 > Cl$. So also for the bases—in the first case, $Na > Mg > Ca$; in the other, $Ca > Mg > Na$—a complete reversal of the order."

Commonly in nature the reaction that takes place in precipitation is the one involving the least exchange of heat or of energy used. The heats of formation of calcium carbonate and magnesium carbonate in the simple reactions, per unit of compound are as follows:[7]

Calcium carbonate, $CaO \cdot CO_2$	451 calories
Magnesium carbonate, $MgO \cdot CO_2$	349 calories

Then under such conditions with a preponderance of magnesium in the ocean waters, with a higher reacting value for the element, magnesium, with less heat exchange, and with less solubility in the salt solution, the precipitated compound, thus leaving the field of chemical activity, should be dolomite and not limestone. Here magnesium oxide, MgO, is the dominating base in such a solution and when this is allowed to react with the carbonic acid, $H_2(HCO_3)_2$ or the acid salt, $Ca(HCO_3)_2$, brought in from the land surface, the resulting product is dolomite. In fresh water, limestone and not dolomite would be the favored precipitate as the acid H_2CO_3 or $H_2(HCO_3)_2$ is abundant and as the base CaO is much in excess of MgO. The resulting products are those of simple precipitation.

In the waters from land areas both the acid and basic components are much different from those of marine waters and consequently the chemical activity of the former will be unlike in some respects from that of the latter. As an example of surface water from the land areas that from the Mississippi River may be taken as representative.[8]

---

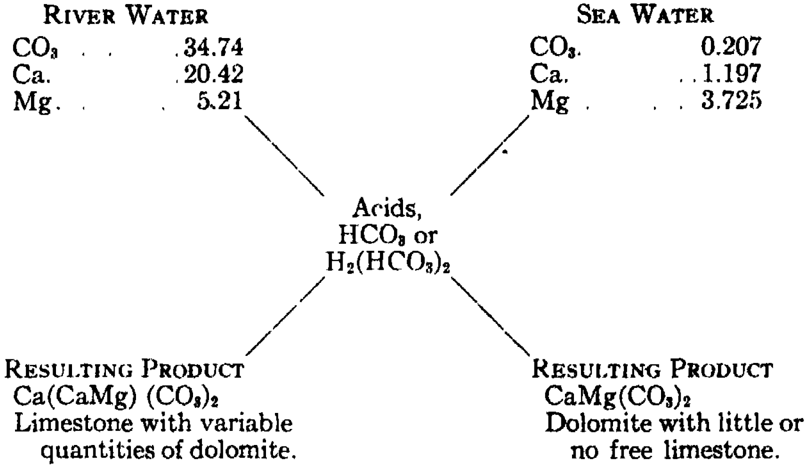
[5] Clarke, Frank Wigglesworth, Data of Geochemistry, Bull. 330, U. S. G. S., pages 94-95.

[6] Clarke, Frank Wigglesworth, Data of Geochemistry, Bull. 330, U. S. G. S., page 107.

[7] Richards, Joseph W., Metallurgical Calculations, Part 1, page 2020.

CO_3	34.74
SO_4	14.90
Cl	6.23
NO_3	1.57
Ca	20.42
Mg	5.21
Na	4.92
K	4.65
SiO_2	6.77
Al_2O_3	0.44
Fe_2O_3	015

In this analysis of river water the Ca is 3.92 times the Mg which is far different from the proportions found in sea water. The content of CO_3 is also high; 34.74 for river water compared to 0.207 for sea water. Further it carries SiO_2, Al_2O_3 and Fe_2O_3 as soluble components. The direct comparison is as follows:



RIVER WATER		SEA WATER	
CO_3	34.74	CO_3.	0.207
Ca.	20.42	Ca.	1.197
Mg.	5.21	Mg.	3.725

Acids,
HCO_3 or
$H_2(HCO_3)_2$

RESULTING PRODUCT
$Ca(CaMg)\ (CO_3)_2$
Limestone with variable
quantities of dolomite.

RESULTING PRODUCT
$CaMg(CO_3)_2$
Dolomite with little or
no free limestone.

In fresh water the resulting product is a limestone with an appreciable but variable quantity of dolomite. Thus the reaction is not complete, yielding pure $CaCO_3$ or $CaCa(CO_3)_2$. However, in sea water, in the large majority of cases, the reaction reaches completion yielding $CaMg(CO_3)_2$, dolomite, with no free limestone and with the true chemical ratio. Under varying conditions mixtures of the two are common.

If dolomite is secondary, that is, first deposited as a limestone then changed to dolomite, much additional work would be involved in the reaction. This requires the solution of the originally precipitated limestone before the exchange of Mg for Ca could take place. Also other reactions would be involved in the adjustment. Such work would be done in a salt solution in which the Mg much exceeds the Ca and in which dolomite is evidently much less soluble than limestone as shown by the solution and disappearance of the shells of fossils in the dolomites, leaving only casts in the rock. The formation of dolomite in sea water is quite simple as "the monovalent ion HCO_3' is formed by preference, and to this some of the characteristic properties of the carbonates are due."[9] Some of these may be represented as follows: HCO_3', monovalent hydrocarbon ion; $Ca(HCO_3)_2$, soluble calcium bicarbonate and $CaMg(CO_3)_2$ dolomite.

---

[8] Clarke, Frank Wigglesworth, The Data of Geochemistry, Bull. 330, U. S. G. S., page 65.

[9] Oswald, Wilhelm, The Principals of Inorganic Chemistry, 1908, page 395.

DATA FROM OHIO

Let us see how this works out in the carbonate rocks of the past geological ages. In Ohio about 335 detailed analyses have been made of the dolomites and limestones in the Permian, Pennsylvanian, Mississippian, Devonian, Silurian and Upper Ordovician systems.[10] Further, some work but in less detail has been done on the rocks of the lower Ordovician and of the Cambrian systems. These analyses were computed to their mineral components, dolomite, $CaMg(CO_3)_2$; limestone, $CaCO_3$; and various other substances. These results are shown on page 224.

FRESHWATER LIMESTONES OF PENNSYLVANIAN AND PERMIAN SYSTEMS

In the coal formations, fresh water limestones make their appearance just under the Middle Kittanning coal of the Allegheny series of the Pennsylvanian system. From this place to the Duquesne coal, about the middle of the Conemaugh series, fresh water limestones are common below the coal beds and marine limestones above them. Above the Skelley limestone, or through the upper part of the Conemaugh series, through the Monongahela series of the Pennsylvanian system and then through the Washington and Greene series of the Permian system, all limestones present, and other strata also, are of fresh water origin. No marine influence is evident. Such strata are limestones in the sense that the dominating component in all cases is calcium carbonate, $CaCO_3$. However, dolomite, $CaMg(CO_3)_2$, is a constant component. In 18 analyses of five members, (Washington, Benwood, Fishpot, Redstone, Summerfield), the most prominent and best developed, the variation is from 3.44 to 24.77 per cent dolomite and the average content 18.01 per cent. The limestone component, $CaCO_3$, varies from 59.13 to 88.63 per cent and the shale and other incidental components from 5.49 to 22.39 per cent. Thus in the freshwater limestone formations the bases occur, as stated by Clarke, in the order $CaO > MgO$, followed by small amounts of K_2O, FeO, Na_2O, and MnO. The acid component, CO_2 or HCO_3', is dominant, with small additions of S_2, SO_4. and P_2O_5. In a way these formations may be considered types for strictly freshwater formations.

MARINE LIMESTONES OF THE PENNSYLVANIAN SYSTEM

In Ohio in the Pottsville, Allegheny and lower Conemaugh series of the Pennsylvanian system a number of marine limestones are present. These vary from a few inches to 20 feet or more in thickness but range commonly between 1 and 8 feet. Marine limestones, if present, occur directly or closely above the coal beds. This is true also of the fossiliferous shales of marine or brackish water origin. Throughout the Pottsville, Allegheny and lower Conemaugh series this repetition of marine or brackish water deposits above the coal beds occurs in 21 out of a total of 31 coals. The coal beds are of land origin as are also the underlying coal formation clays. Further, some of the shales and sandstones are thus derived. The marine limestones and fossiliferous shales were deposited when subsidence first carried down the carbonaceous land surface, on which had developed the clays and the coals, to such a level that inundation by sea water took place. They were thus laid down in shallow, relatively quiet and silt free waters at the close of the coal forming stages. Under such conditions the marine waters were certainly more or less diluted with fresh water as on the average the coal beds are repeated about every 21 feet in the column. The marine waters also had excellent opportunities for charges of carbonic acid, HCO_3', or $H_2(CO_3)_2$. Six of such limestone members

---

[10] Geological Survey of Ohio, Bull. 42, *Dolomites and Limestones of Western Ohio* and unpublished analyses of limestones in eastern Ohio.

FRESHWATER LIMESTONES

Name of Formation	Average Thickness in Feet	Number of Samples	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Argillaceous Siliceous and Other Impurities
PERMIAN SYSTEM					
Washington	9	1	3.44	88.63	7.93
PENNSYLVANIAN SYSTEM					
Benwood	37	2	9.99	76.04	13.97
Fishpot	32	10	24.77	59.13	16.10
Redstone	13	2	15.33	62.28	22.39
Summerfield	12	3	7.46	87.05	5.49

MARINE LIMESTONES

PENNSYLVANIAN SYSTEM					
Ames	1½	5	3.40	86.22	10.38
Cambridge	4	3	3.19	58.12	38.69
Brush Creek	20	2	3.80	33.04	63.16
Vanport	6	7	2.61	90.59	6.80
Putnam Hill	4	16	4.49	88.72	6.79
Lower Mercer	2	5	4.64	86.77	8.59
MISSISSIPPIAN SYSTEM					
Maxville	20	5	19.83	70.38	9.79
DEVONIAN SYSTEM					
Delaware	45	12	30.46	55.81	13.73
Columbus—top	50	20	29.00	67.96	3.04
—bottom	40	24	84.72	11.69	3.59
Lucas	50	6	86.30	9.50	4.20
Amherstburg	15	1	83.23	14.23	2.54
SILURIAN SYSTEM					
Monroe	570	85	93.90	2.34	3.76
Guelph-Cedarville	170	64	98.02	0.20	1.78
Springfield-West Union	20	21	84.40	3.13	12.47
Euphemia	6	3	96.55	0.76	2.69
Laurel	6	3	78.78	12.85	8.37
Dayton	8	5	70.01	17.20	12.79
Brassfield	27	17	22.29	72.23	5.48
Elkhorn	63	1	25.10	1.75	73.15
ORDOVICIAN SYSTEM					
Upper Part					
Richmond	265	1	10.69	66.47	22.84
Maysville	205	4	4.33	47.89	47.78
Eden	245	2	7.88	45.05	47.07
Utica	170	2	13.22	23.60	63.18
Trenton	185	1	12.57	74.84	12.59
Black River	425	2	14.14	79.83	6.03
Glenwood	10	1	22.99	4.04	72.97
ORDOVICIAN SYSTEM[11]					
Lower Part					
LOWER MAGNESIAN[12]	450	24	95.00	1.00	4.00
CAMBRIAN SYSTEM[13]	715	52	54.49	0.81	44.70

[11] Partial analyses and microscopic work show dolomite with high purity.

[12] Partial analyses and microscopic work show dolomite with high purity.

[13] Partial analyses and microscopic work show dolomite with fair purity, cut by many sandstone strata.

Crystalline rocks, mainly gneiss.

(Ames, Cambridge Brush Creek, Vanport, Putnam Hill, Lower Mercer) were sampled, 38 tests in all being made. In these the dolomite component $CaMg(CO_3)_2$, is quite low, varying from 2.61 to 4.49 per cent and averaging 3.89 per cent. The deposits are thus rich in limestone, CaCO, the common range being between 50 and 90 per cent. Further, they are variable but generally low in argillaceous, siliceous and other impurities. Hence they conform to deposition in diluted marine waters where the acid, HCO_3', or $H_2(HCO_3)_2$, was abundant and the bases largely supplied directly or indirectly from land sources.

MAXVILLE FORMATION

The Maxville formation of the Mississippian system is patchy in development in Ohio. Thus the deposits are broken, more or less scattered and variable in thickness A break or unconformity is present both at the top and at the bottom of the formation. The thickness varies from 1 to 140 feet or more It is of marine origin as shown by the fossils which, however, are not abundant and are confined largely to the shaly partings along the bedding planes. In general this limestone is finely crystalline, dense and hard. The underlying formations, 300 to 600 feet or more in thickness, are the shales, sandstones and conglomerates, all of marine origin but chiefly of land derived materials. In Ohio the upper, much worn and eroded surface of the Maxville formations is in contact with the Pottsville rocks of the Pennsylvanian system. The lost interval here represents the Mauch Chunk of the Appalachian Mountains area. In Ohio, where thick, the upper part of the Maxville formation is a limestone rich in calcium carbonate, $CaCO_3$, low in dolomite, $MgCO_3 \cdot CaCO_3$, and generally low in the common impurities. This part is used in the manufacture of Portland cement. However, the lower portion is quite dolomitic in character, being classed as a limey dolomite. In five samples, from top to bottom, the range of components is, dolomite, $CaMg(CO_3)_2$, 1.84 to to 72.81 per cent and limestone, $CaCO_3$, 4.18 to 95.25. The respective averages are 19.83 per cent for the former and 70 38 per cent for the latter. The lower portion thus shows the influence of marine conditions not far from land areas and the upper portion bears more toward shallow marine conditions in advance of the coal formation stages.

DELAWARE FORMATION

The Delaware formation in Ohio varies from 30 to 70 feet in thickness but averages close to 45 feet. It is a limestone, dark gray to dark with carbonaceous pigments, rather dense in character, often flinty and commonly rich in marine fossils. It is overlain directly by the Olentangy shale and this in turn by the Ohio shale rich in organic matter. The total shale covering is thus several hundred feet of land derived materials. The Delaware formation is underlain locally by the Marcellus shale, much like the Ohio in character, that is, black and carbonaceous but otherwise of land derived materials. Along much of the outcrop the Delaware lies unconformably on the Columbus formation. From 12 analyses, spaced over a wide area the Delaware should be classed as a dolomitic limestone of only moderate purity. On the average the dolomite component, $CaMg(CO_3)_2$, is 30.46 per cent, the limestone component, $CaCO_3$, is 55.81 per cent and the siliceous, argillaceous and other ingredients are 13.73 per cent. In these analyses the minimum and maximum figures are, dolomite, $CaMg(CO_3)_2$, 14.21 and 52.83 per cent and the limestone, $CaCO_3$, 35.73 and 78.16. The composition thus indicates that the formation was laid down in sea water somewhat diluted by fresh water which was rich in the acid, HCO_3' and contained bases in the proportion of $CaO > MgO$.

COLUMBUS FORMATION, UPPER PART

The upper part of the Columbus formation, from 50 to 60 feet in thickness, and made up of the Klondyke and Coral members in central Ohio and the Venice and Marblehead in northern Ohio, is consistently a limestone, light to light gray in color, rich in fossils and earthy to dense crystalline in texture. It is overlain by the Marcellus black shale or by the disconformity marking the stratum. On the other hand the basal portion of the Columbus formation is a dolomite with a small content of limestone, $CaCO_3$. Wherever tested the upper portion shows a distinct gradation downward in the content of $MgCO_3$. For example at Columbus the figures are:

	Thickness		$MgCO_3$	$CaCO_3$
	ft.	*in.*		
Sample 241, top	14	3	5 10	91 90
242	11	3	10 90	86 76
243	16	6	12 88	84 98

At the O'Shaughnessy Dam in Delaware County the results are:

	Thickness		$MgCO_3$	$CaCO_3$
	ft.	*in.*		
Sample 209 Klondyke, top member	22	0	7.32	90.13
207 Coral	23	7	11.31	86.33
206 Eversole	10	1	28.44	61.08
208 Bellepoint	14	4	39 90	58 04

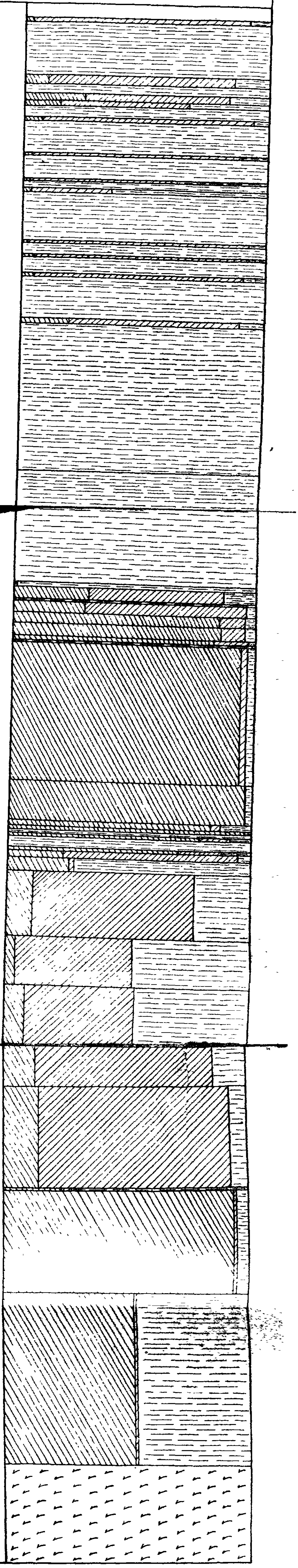
In general the upper part of the Columbus formation must be classed as a limestone, always somewhat dolomitic in character and rather low in the common impurities. In 20 samples taken across Ohio the dolomite component, $CaMg(CO_3)_2$, varies from 9 23 to 66.91 per cent and averages 29.00 per cent. The limestone component, $CaCO_3$, runs as low as 26.88 per cent and as high as 89.75 per cent. The common impurities average about 3.04 per cent. Thus the data would indicate that the upper portion of the Columbus formation was laid down in marine waters, slightly diluted with fresh water bearing little sediments.

COLUMBUS FORMATION, LOWER PORTION

The lower portion of the Columbus formation, 20 to 50 feet in thickness· imparts a different story as far as origin is concerned. It is usually slight brownish gray to light brown in color, definitely crystalline in texture, impoverished in fossils, then only casts, and locally impregnated with chert. It is directly overlain, with only a bedding plane for parting, by the upper portion of the Columbus formation and underlain by formations of the Detroit River group or by the disconformity marking the absence of a thick section of such rocks. Rather commonly the Columbus formation rests on the Monroe dolomite. Little or no land derived sediments are found within basal Columbus rocks or are found associated in the older formations. They are marine in origin with little influence from fresh water changes. From 24 samples gathered over a wide area in western Ohio and representative of the formation the dolomite component, $CaMg(CO_3)_2$, varies from 44.17 to 97.27 per cent and averages 84.72 per cent. On the other hand the free limestone, $CaCO_3$, varies from 0.00 to 53.72 per cent and averages only 11.69 per cent. The two carbonates make up all but 3.59 per cent of the total. Such rocks were laid down by precipitation in sea water closely normal in concentration.

OHIO SECTION TO SCALE WITH COMPOSITION

FORMATION	MATERIAL	THICKNESS FEET	NO OF SAMPLES	DOLOMITE $CaMg(CO_3)_2$	LIMESTONE $CaCO_3$	IMPURITIES
PERMIAN SYSTEM						
WASHINGTON	FRESH WATER LM	9	1	3.44	88.63	7.93
PENNSYLVANIAN SYSTEM						
		227				
BENWOOD	FRESH WATER LM	37	2	9.99	76.04	13.97
		45				
FISHPOT	FRESH WATER LM.	32	10	24.72	58.13	18.10
REDSTONE	FRESH WATER LM	15	2	15.38	62.26	32.39
		57				
SUMMERFIELD	FRESH WATER LM	12	3	7.46	87.05	5.49
		140				
AMES	MARINE LM.	2	5	3.40	86.22	10.38
		95				
CAMBRIDGE	MARINE LM	4	3	3.19	58.12	38.69
		29				
BRUSH CREEK	MARINE LM	20	2	3.80	33.04	63.16
		204				
VANPORT	MARINE LM	6	7	2.61	90.59	6.80
		53				
PUTNAM HILL	MARINE LM	4	18	4.49	88.72	6.79
		80				
LOWER MERCER	MARINE LM.	2	5	4.64	86.77	8.59
MISSISSIPPIAN SYSTEM		175				
MAXVILLE	MARINE LM	20	5	29.83	70.38	9.79
WAVERLY SUNBURY BEREA BEDFORD	SHALE AND SANDSTONE	655	10	0.00	0.00	100.00
DEVONIAN SYSTEM						
OHIO	SHALE	600	5	0.00	0.00	100.00
OLENTANGY DELAWARE MARCELLUS COLUMBUS TOP BOTTOM LUCAS AMHERSTBURG ORISKANY	SHALE LIMESTONE SHALE LIMESTONE DOLOMITE DOLOMITE DOLOMITE SANDSTONE	20 45 10 50 40 50 15 10	2 12 20 24 6 1	0.80 30.46 0.00 29.06 84.72 86.30 83.23	1.00 55.81 1.00 67.96 11.69 9.50 14.23	99.00 13.73 99.00 3.04 3.59 4.20 2.54
SILURIAN SYSTEM						
MONROE	DOLOMITE	570	85	93.90	2.34	3.76
GUELPH-CEDARVILLE	DOLOMITE	170	64	98.02	0.20	1.78
SPRINGFIELD EUPHEMIA MASSIE LAUREL OSGOOD DAYTON BRASSFIELD ELKHORN	DOLOMITE DOLOMITE SHALE DOLOMITE SHALE DOLOMITE LIMESTONE SHALE	20 6 5 8 45 6 27 63	21 5 3 5 17 1	84.80 96.55 78.78 70.01 22.29 25.10	3.13 0.78 12.85 17.20 72.23 1.75	12.07 2.69 8.37 12.79 5.48 73.15
ORDOVICIAN SYSTEM						
RICHMOND	SHALE AND LM.	265	1	10.89	66.47	22.64
MAYSVILLE	SHALE AND LM.	205	4	4.33	47.88	47.78
EDEN	SHALE AND LM.	245	2	7.88	45.05	47.07
TRENTON	LIMESTONE	185	1	12.57	74.84	12.59
BLACK RIVER	LIMESTONE	425	2	14.14	79.83	6.03
GLENWOOD	SHALE AND DOLOMITE	10	1	22.99	4.04	72.97
LOWER MAGNESIAN	DOLOMITE	450		95.00	1.00	4.00
CAMBRIAN SYSTEM						
CAMBRIAN	DOLOMITE	75		54.49	0.81	44.70
CRYSTALLINE ROCKS						



LEGEND

▨ DOLOMITE
▤ SHALE & ETC.
▨ LIMESTONE
▦ CRYSTALLINE

Dolomites—Wilber Stout

(Insert pp. 227—228)

LUCAS FORMATION

In Ohio the Lucas formation is local in distribution and is confined to an outcrop in western Lucas, northwestern Wood and southeastern Henry counties. The thickness is erratic, the maximum given being about 140 feet. The Lucas is characteristically a dolomite but locally becomes calcareous in composition.

The formation is rather definitely bedded, the layers commonly ranging from 3 to 12 inches in thickness. The stone varies from light bluish gray to light brown or drab in color. Disconformities exist both at the top and at the bottom of the formation but in any event the underlying and overlying strata are dolomites and not limestones. From 6 representative analyses the dolomite component, $CaMg(CO_3)_2$, varies from 53.68 to 97.93 per cent and averages 86.30 per cent. The limestone component, $CaCO_3$, ranges from 0.00 to 44.90 per cent but averages 9.50 per cent. The stone is moderately high in purity as the two carbonate components make up all but 4.20 per cent of the total. Both the geological and chemical data suggest that the Lucas formation was deposited under marine conditions with only slight local modifications from land influence

AMHERSTBURG FORMATION

The lower formation, the Amherstburg, of the Detroit River group, in Ohio, is confined to two areas, one east of the Cincinnati arch in Ottawa, Erie and Sandusky counties and another west of this structure in Lucas, Wood and Henry counties. The rock is a dolomite in composition, slight drab to brownish gray in color, open or even cavernous in texture and usually massive in bedding. The thickness where best developed appears to vary between 50 to 75 feet. It is overlain mainly by the Lucas formation, a dolomite, and underlain by the Oriskany sandstone or by the disconformity marking this stratum. Commonly the underlying formation is the Monroe, strictly a dolomite in composition. The one analysis for the Amherstburg shows, dolomite, $CaMg(CO_3)_2$, 83.23 per cent, limestone, $CaCO_3$, 14.23 per cent and impurities 2.54 per cent. The lenticular and patchy nature of the deposits suggests marine origin with slight land influence

MONROE FORMATION

The Monroe formation in Ohio includes the Greenfield, Tymochtee, Put-in-Bay and Raisin River divisions which, however, are not definitely separated one from another and are very similar in geological, physical and chemical features. Here these four members are treated as one formation. The thickness of these rocks varies from 400 to 700 feet and averages about 570 feet. They may present a shelly, very thin, thin, medium or massive structure. Such variations may be found in almost any quarry face or throughout any considerable part of the entire section In general the materials are slightly siliceous in character, the free silica content being a rather distinguishing element. The color range is wide but in general the tints exhibited are some shades of brown or dark bluish gray. In texture the stone changes from hard and dense to open, sugary or even cavernous. Parts are very definitely laminated through the effects of thin papery partings of dark-colored matter which suggests the concentration of organic scums during dry land periods. Breccias, mud cracks and ripple marks are common impressions In the Monroe dolomites the fossils are not abundant, are small in size, and are usually preserved as casts. The anhydrite and gypsum deposits of central and northern Ohio and the salt beds, over 7,000 square miles, throughout the eastern part of the State are ordinarily present about midway in the section. The data are definite and conclusive and shows deposition in normal or even concentrated sea water under shallow water condition. During many times the basin became mud flats exposed to the sun. In no way is alteration, substitution or secondary changes evident. The material was deposited as dolomite. The Monroe is overlain by the Oriskany sandstone or if this is not present by some dolomite formation, and underlain by the great Guelph-Cedarville dolomite also of high purity.

The Monroe formation in Ohio was thoroughly examined and sampled throughout its entire exposed range in the western part of the state. In an average of 85 samples the components are dolomite, $CaMg(CO_3)_2$, 93.90 per cent; limestone, $CaCO_3$, 2.34 per cent and impurities 3.76 per cent. In 42 of these samples the free limestone, $CaCO_3$, ranged from 0.00 to 0.10 per cent and in 24 others from 0.10 to 0.25 per cent. The only ones showing any considerable amounts of free limestone were in south-central Ohio abutting the area of overlap where the underlying Niagara limestone was a land surface through upper Silurian and lower Devonian time. Here in a small area the rock becomes a dolomitic limestone. Aside from this the Monroe conforms strictly to direct deposition as a dolomite, close to the true chemical ratio. It was laid down as a primary deposit in shallow marine waters, generally normal or above in saturation.

GUELPH-CEDARVILLE FORMATION

The Guelph-Cedarville formation of the Niagara group covers a wide area in Ohio. In southern and southwestern Ohio such rocks are exposed in sixteen counties and in the north-central part of the area in eight counties. The thickness varies from 80 to 200 feet. The rock is highly crystalline, usually open and porous in texture, nearly white, light gray or bluish gray in color and always of high purity. The formation is massive in structure, thick faces often showing few if any well-defined partings. In local areas some chert appears in the lower portion in 5 to 25 feet of strata. The rock is everywhere a true dolomite, at or very close to the dolomitic ratio. The Guelph-Cedarville formation is overlain by the Monroe dolomite and underlain by the Springfield-West Union dolomite, another division of the Niagara group. Throughout the area of outcrop the Guelph-Cedarville formation was carefully sampled for testing, in all 65 samples were taken and tested. The average of these show, dolomite, $CaMg(CO_3)_2$, 98.02 per cent; limestone $CaCO_3$, 0.20 per cent and impurities 1.78 per cent Of these, 42 samples had a free limestone content, $CaCO_3$, of 0.10 per cent or less and only 6 had quantities above 0.50 per cent. In the true Guelph of northern Ohio the average content of silica, SiO_2, is about 0.16 per cent and that of alumina, Al_2O_3, is not more than 0.05 per cent. The minimum recorded is 0.05 SiO_2 and 0.02 Al_2O_3. In the Cedarville of southern Ohio these components average close to 0.54 SiO_2 and 0.13 Al_2O_3. Such contents of silty materials certainly show these seas had little contact with land areas. The Guelph-Cedarville formation is thus a dolomite of exceptionally high purity, with little or no free limestone, $CaCO_3$, and evidently deposited under true marine conditions.

SPRINGFIELD-WEST UNION FORMATION

A definite group of strata of lenticular character near the base of the Niagara series is termed the Springfield-West Union formation. These deposits outcrop over a rather wide area in southwestern Ohio, vary in thickness from 10 to 40 feet and in general are dolomites somewhat siliceous in composition. They are directly overlain by the great Guelph-Cedarville formation and underlain by a series of calcareous shales and thin dolomites. The formation was carefully sampled throughout the area. In 21 samples the average components are: dolomite, $CaMg(CO_3)_2$, 84.40 per cent; limestone, $CaCO_3$, 3.13 per cent and impurities 12.47 per cent. The free limestone, $CaCO_3$, varies from 0.10 to 18.14 per cent and commonly—in 14 of 21 samples—ranges between 1.00 and 5.00 per cent. These analyses thus show a tendency towards slight dilution of the sea water or influence from land areas.

EUPHEMIA FORMATION

The Euphemia formation is the basal portion or a lens-like stratum of the great mass of Niagara dolomites. The rock is massive, porous and more or less mottled and commonly rich in fossils, preserved mainly as casts. The formation is relatively thin, averaging only about 6 feet. The outcrop of the member is confined to five counties. Three samples show the following average components: dolomite, $CaMg(CO_3)_2$, 96.55 per cent; limestone, $CaCO_3$, 0.76 per cent and impurities 2.69 per cent. The range of free limestone, $CaCO_3$, is from 0.00 to 2.24 per cent. The deposits are thus of marine origin in sea water close to normal in concentration.

LAUREL FORMATION

The Laurel formation is a thin, rather local unit, bedded in the calcareous shales, underlying the great body of Niagara dolomite. It is directly overlain by the Massie shale and underlain by the Osgood shale, both of which are made up largely of much land derived sediments. The rock is finely crystalline, dense and hard, is bluish gray in color and somewhat fossiliferous. Three analyses, relatively representative, furnish the following data on components: dolomite, $CaMg(CO_3)_2$, 78.78 per cent, limestone 12.85 per cent, and impurities 8.37 per cent. Its interbedding in shales, free limestone and moderate impurities all indicate influence from fresh water from land areas.

DAYTON FORMATION

The basal formation of the Niagara group is the Dayton member. It is directly overlain by the Osgood shales and underlain, with a slight disconformity, by the Brassfield limestone. The deposits are thin, varying from 7 to 13 feet and averaging only about 8 feet. The stone is thin bedded, compact, tough, crystalline and fossiliferous. In composition it is commonly a siliceous, limy dolomite. The results of five determinations are as follows: dolomite, $CaMg(CO_3)_2$, 70.01 per cent, limestone, $CaCO_3$, 17.20 per cent and impurities 12.79 per cent. The variation in dolomite is from 68.14 to 73.21 per cent and in limestone from 15.40 to 20.01 per cent.

A study of the preceding formations shows an increase downward in the quantity of free limestone, $CaCO_3$, and in the quantity of shale sediments for example:

	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
Guelph-Cedarville formation	98.02	0.20	1.78
Springfield-West Union formation	84.40	3.13	12.47
Euphemia formation	96.55	0.76	2.69
Laurel formation	78.78	12.85	8.37
Dayton formation	70.01	17.20	12.79

Thus the shift is from dolomites towards limestones which are the predominating rocks in the great mass of shales several hundreds of feet in thickness in the basal portion of the Silurian and in the upper part of the Ordovician systems. Hence the shift is from normal marine waters toward that diluted by fresh water from the land surfaces.

BRASSFIELD FORMATION

The Brassfield limestone in the lower part of the Silurian system is, in a way, placed out in a shale section and is a dolomitic limestone of fair purity. It is underlain by the Elkhorn or Red Medina shale and this in turn by that shale-limestone series of the Cincinnati group, in all about 900 feet in thickness. The Brassfield formation thus shows the influence of land or fresh water conditions.

The Brassfield member is from 20 to 40 feet in thickness and averages about 30 feet. It varies laterally from massive strata to thin bedded layers with shale partings. In color it ranges from a very light gray, nearly white, through darker shades of gray, buff and pink to brownish red. Marine fossils are abundant, being most concentrated along the partings. In composition the formation gradates downward from a relatively pure limestone at the top to one decidedly dolomitic at the bottom. This relationship is shown below:

Sample Number	Thickness		$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
	ft.	*in.*					
275	9	4	3 35	95.86	7 33	91 88	0 79
274	9	5	15 25	83 94	33.35	65 84	0 81
273	6	9	20 75	78 23	45 38	53 60	1 02

The average of 17 samples representing all parts of the formation along its entire outcrop in southwestern Ohio yields the following: dolomite component, $CaMg(CO_3)_2$, 22.29 per cent, limestone component, $CaCO_3$, 72.23 per cent and impurities 5.48 per cent The range in dolomite, is from 3.30 to 81.85 per cent and in limestone, from 9.37 to 91.88 per cent. Thus during the deposition of the Brassfield formation the conditions were variable but always were more or less influenced by fresh water from the land areas.

ELKHORN OR RED MEDINA FORMATION

The Elkhorn shale of Ohio is the Red Medina of the driller and the Queenstown of the New York section. It is regional in distribution but variable in thickness. In Ohio, it ranges from 10 to 250 feet but averages not far from 60 feet. The Elkhorn member is a typical shale in character but locally contains sandy lenses and limy matter. The color of the drill cuttings is distinctive, being red or brownish red. In composition it is classed as a siliceous, dolomitic shale rich in potash K_2O, and in hematite, Fe_2O_3. The testing of one sample from an oil well gave the following results:

Sample Number	Thickness		$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
	ft.	*in*					
219	56	0	11 48	15 37	25 10	1 75	73 15

The analysis shows that the Elkhorn is a shale, argillaceous, ferruginous and siliceous from land derived components and dolomitic from marine components.

RICHMOND, MAYSVILLE AND EDEN FORMATION

The Richmond is the upper formation of the Cincinnati group of the Ordovician system and is closely similar in every respect to the underlying Maysville and Eden formations. All are made up of great series of shales and limestone laid down with little alteration of the physical conditions. They were deposited in marine water, most certainly modified as to concentration. Here shale and limestone are repeated in rapid succession through a great thickness, 700 feet, of strata.

The deposits of the three formations are made up of alternate layers of shale and limestone, generally sharply defined but rather uniformly spaced. The hard carbonate rocks form from 20 to 50 per cent of the whole. These limestone strata range from 1 inch or less to 10 inches in thickness and are interbedded with the shale, always calcareous in nature. The shale partings are on the average somewhat thicker than the limestone layers. The compositions of these formations as shown by a few analyses are given below:

	Thickness, feet	$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities, Shale, etc.
Richmond						
Stone and shale .	265	4 89	72.27	10 69	64.47	22 84
Maysville. ..	205	......	.....	...	.....	...
Stone...	. .	1.61	83 26	3 52	81.35	15 13
Shale...		2.40	14 53	5 25	11 68	83 07
Stone .	. .	2.20	85 62	4 81	83 01	12 18
Shale .	..	1.72	17.54	3.76	15 50	80 74
Eden .	245	....	...	......	...	...
Stone..	...	2 32	82 26	5 07	79 51	15 42
Shale. .		4 89	16 39	10 69	10 59	78 72

In composition these limestones closely duplicate the marine limestone of the Pennsylvanian system or of the coal formations. The bases conform to land or fresh water origin where the CaO > MgO. The associated shales are slightly more dolomitic in character. This rapid succession of shale-limestone, shale-limestone, repeated hundreds of times may be accounted for by seasonal inundations from the land areas which thus brought in greater supplies of bases, CaO > MgO, at each particular time. In a way it is comparable to the conditions in the Pennsylvanian system where inundations of the coal swamps, with diluted marine waters, gave rise to limestones or fossiliferous calcareous shales. Every coal bed in the Pottsville series and most of them in the Allegheny and lower Conemaugh series are directly or closely overlain by a marine limestone or fossiliferous shale. The end results in both cases, Cincinnatian and Pennsylvanian, are closely alike.

UTICA FORMATION

In Ohio, as detected by the drill, this formation ranges from 25 to 400 feet in thickness but averages close to 300 feet. It consists of calcareous, carbonaceous shales and shaly limestone, the latter being most concentrated in the lower portion. In color the Utica is conspicuous, ranging from brown to black, quite similar to the Marcellus, Ohio and Sunbury shales. The composition is shown below:

Sample Number	Thickness in Feet	$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Shale, etc.
216	310	4.47	21 75	9 77	16 45	73 78
217.	16	7 63	39.80	16.68	30 75	52 57

The organic nature of the coloring pigment is shown by the presence, in sample No. 216, of 0.33 per cent hydrocarbons, C_nH_{2n+2}. Both the organic matter, the shale component and the composition show the influence of land masses.

TRENTON AND BLACK RIVER FORMATIONS

The Trenton and Black River formations, commonly designated Trenton by the driller, make up a thick mass of carbonate rocks, averaging over 600 feet in thickness, which extends regionally across the state. These rocks are dark gray to dark in color, generally fine and dense in texture and vary from dolomitic limestones to true dolomites in composition. Where tested in the southwestern and central parts of Ohio they are limestone but in the northwestern part, in the old

Lima oil field, they are open, porous dolomites. The three analyses following are from the limestone area.

Sample Number	Thickness in Feet	$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
Trenton						
220	185	5.75	81.66	12.57	74.84	12.59
Black River						
221	149	6.57	85.76	14.37	77.96	7.67
222	272	6.36	89.26	13.91	81.71	4.38

The composition of the Trenton and Black River formations indicates that these rocks were laid down in the sea where the conditions of salinity shifted, commonly depositing dolomitic limestone but more locally yielding dolomite.

LOWER ORDOVICIAN AND CAMBRIAN SYSTEMS

In Ohio where tested by the drill the rocks from the St. Peter sandstone of the Ordovician system through the Cambrian to the crystalline rocks of pre-Cambrian age are essentially dolomites and sandstone, the latter bedded in the former. From one set of 76 rough analyses the composition may be approximated about as follows:

	Thickness in Feet	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Sand and Other Impurities
Ordovician System				
Lower Magnesian	450	95.00	1.00	4.00
Cambrian System				
Upper part	580	66.00	1.00	43.00
Dresbach	135	5.00	0.00	95.00
Total.	715	54.49	0.81	44.70
Crystalline rocks.				

The composition thus indicates normal marine deposits where the bases stand $Na > Mg > Ca$ and the acids $Cl > SO_4CO_3$.

CONCLUSIONS

A summary of the results of the composition of the carbonate rocks in the entire section in Ohio from the crystalline rocks through the Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian and Permian systems to the unconsolidated recent materials is as given below:

Geological System	Thickness of Rock Tested	Dolomite Component $CaMg(CO_3)_2$ in per cent	Limestone Component $CaCO_3$ in per cent	Shale and Other Impurities in per cent
Permian	9	3.44	88.63	7.93
Pennsylvanian	131½	12.08	65.81	22.11
Mississippian	20	19.83	70.38	9.79
Devonian	200	58.86	35.33	5.81
Silurian	870	86.98	4.26	8.76
Ordovician				
Upper	1,505	10.94	60.00	29.06
Lower	450	95.00	1.00	4.00
Cambrian	715	54.49	0.81	44.70
Total	3,900½	48.10	28.96	22.94

Thus in the 3,900 feet of tested carbonate materials in a total section of 6,796 feet the dolomite component, $CaMg(CO_3)_2$, stands in the ratio to the limestone component, $CaCO_3$, of 48.10 to 28.96 or approximately about 5 to 3. The data show that the Silurian, lower Ordovician and Cambrian carbonate rocks are nearly entirely true dolomites. In the Devonian system the quantity of dolomite much exceeds that of limestone. In all of these true marine conditions of deposition prevailed. However, in the Permian, Pennsylvanian, Mississippian and Upper Ordovician systems the quantity of limestone much exceeds that of dolomite. Here the shift of conditions is toward fresh water or land influences. True dolomites were deposited in great masses (shown by over 80 samples) but pure limestones do not occur at any place in the section. The evidence from Ohio is quite conclusive and supports the view that dolomites are the natural deposits of the ocean where the salinity of the water is about normal, that is, where the bases stand $Na > Mg > Ca$ and the acids stand $Cl > SO_4CO_3$. On the other hand limestones are deposited when the sea waters are somewhat diluted by fresh water from land areas in which the reacting components are largely found in the ratio of bases $Ca > Mg > Na$ and of acids $CO_3 > SO_4 > Cl$ or are tending in that direction. Hence both dolomites and limestones are primary in origin and have not undergone any alteration, one to the other.

Evolution

Some excellent books on organic evolution have appeared in recent years. Each of these has considered the subject from the viewpoint of new advances in some one field of biological science. Huxley's book is unique in that he has made a synthesis of " new facts or new tools of research" from many disciplines. The subject is so broad and the material so abundant that it is impossible for the author to present more than the broad principles in a book of this size. From numerous citations many of the details are left for the individual reader to work out for himself. There is a very complete bibliography and three indices, "Subjects," "Organisms" and "Authorities." The book is superbly written. Professional biologists, interested in problems of evolution, should find it on their list of books which must be read.

In the first two chapters the broad principles are stated and the plan of the book sketched. Genetics' contribution to evolution is discussed in the third and fourth chapters. This section is much reduced and assumes the readers' knowledge of the principles of heredity. The next three chapters, consisting of three hundred and sixty pages, are devoted to a discussion of geographical, ecological and genetic speciation. The inclusion of maps would have made this section more readable. In the eighth chapter Huxley maintains that adaptations are a fact and can be explained upon good "mechanistic principles." His explanation for their origin is by natural selection. In general this difficult subject is skillfully handled However, several of his examples of adaptations imply teleology. On page 422 he states, ". . . Thus various desert butterflies spend most of their active life flying about inside quite small bushes, in order to avoid being blown away." Upon the same page we find " . In Equidae the subcutaneous muscle sheet is highly developed so as to be capable of strong twitching." These are peculiarities of expression and in no sense meant to be teleological.

The ninth chapter is devoted to a discussion of evolutionary trends leading to specializations. In the last chapter, the tenth, Huxley looks into the future of man. He predicts that, in the near future, man is not destined to break up into a number of separate radiating lines. Changes leading to his evolutionary progress will be concerned with the attributes of the mind. He leaves the reader with the thought that man is the trustee of his own evolution and if rapid progress is to be made he must work and plan for it.—*W. M. Tidd.*

Evolution: The Modern Synthesis, by Julian Huxley, xi and 645 pages; no text figures. Harper and Brothers, publishers, New York and London. Price $5.00.

A NEW GENUS (TENUCEPHALUS) AND SPECIES OF MEXICAN LEAFHOPPER RELATED TO PARABOLOCRATUS

DWIGHT M. DeLONG
Department of Zoology and Entomology
The Ohio State University
Columbus, Ohio

Several new and interesting generic forms of Mexican leafhoppers have recently been collected The genus and species described below is apparently allied to *Parabolocratus* and *Spangbergiella.*

Genus Tenucephalus n. g.

In appearance resembling Parabolocratus superficially, but smaller with a short broadly rounded vertex. The vertex is broader than long, with a definite margin, but the margin is not thin or foliaceous. The face is more inflated than in Parabolocratus. The ocelli are on the margin and close to the eyes. The elytra are long and narrow and the venation resembles the Thamnotettix type. In Parabolocratus the first anteapical cell is almost as long as the second anteapical and the cross veins just caudal to these cells are in a straight line. The elytron of Tenucephalus differs in having a short first anteapical cell, a long second anteapical and a long third apical cell. The cross veins between the second anteapical and second apical are therefore decidedly more caudal than the other cross veins. The pygofer and ovipositor are extremely long and resemble the Aconuran type.

Genotype *Tenucephalus marginellus* n. sp.

Tenucephalus marginellus n. sp.

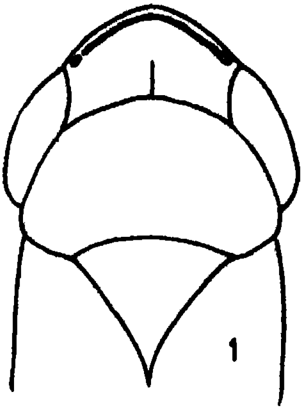
Most closely resembling *Parabolocratus viridis* but much smaller with a narrow black band just above and another just below the pale marginal band. Length, female 4.5 mm.

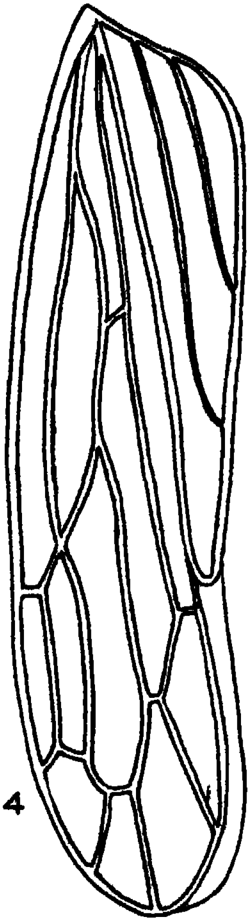
Vertex broadly roundedly produced, more than one-third wider between eyes at base than median length. Disc flat. Pronotum one third longer than vertex. Body slender.

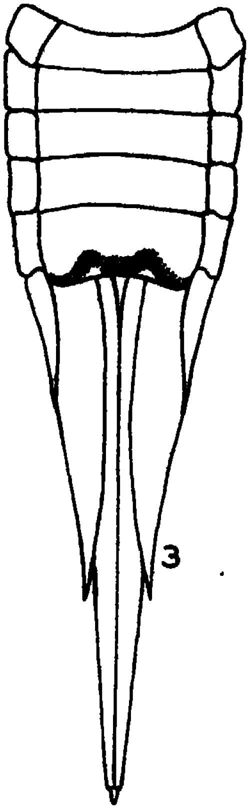
Color: Dull grayish-green tinged with yellow. Vertex yellow except for a narrow black marginal line just above the pale marginal band. Another narrow black line is just beneath the marginal band. Anterior half of pronotum yellow, basal portion darker. Scutellum and beneath yellow.

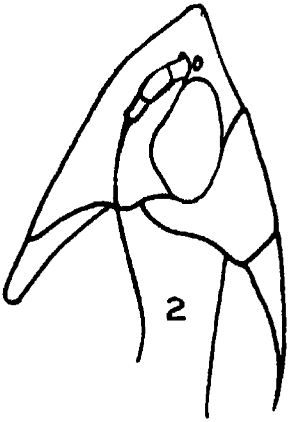
Genitalia: Female last ventral segment with posterior margin broadly, concavely rounded between the produced lateral angles. The central third appears notched either side of a broad sunken tooth due to the brown markings on the segment margin and the transparent condition of the central portion of the margin. The pygofer is long, tapered and together with the ovipositor is longer than all of the abdominal segments combined. Male plates short, broadly rounded at apex. Pygofer twice as long as plates with a spine on either side arising from inner wall and concealed under apical fourth. Aedeagus forming an inverted U with the posterior arm longer and heavier than the anterior arm. At the apex of the posterior arm is a horizontal, less heavily chitinized, elongate lobe which is covered with spines on ventral margin. At the base of the U arises on the ventral side a long slender process which extends almost to apex of pygofer. Style broad at base, the apical half less than half the width of the basal portion, truncate at apex and bent outwardly.

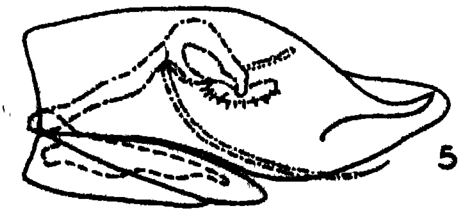
Holotype male, allotype female and female paratypes from Iguala, Guerrero, Mexico, October 25, 1941, collected by E. E. Good and the author. Types in author's collection.

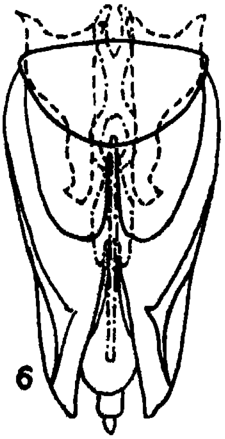

1


4


3


2


5


6

1. Dorsal view of head, thorax and scutellum.
2. Lateral view of head, thorax and scutellum.
3. Ventral view of female abdomen.
4. Lateral view of elytron.
5. Lateral view of male genital structures in situ.
6. Ventral view of male genital structures in situ.

NEW SPECIES OF ZYGNEMATACEAE[1]

CLARENCE E. TAFT
The Ohio State University
Columbus, Ohio

Six undescribed species of the Zygnemataceae were discovered in collections recently examined from Texas, Louisiana, and Florida. These have been described and are now being reported.

Spirogyra miamiana sp. nov.

Vegetative cells 20–25μ x 150–340μ, with plane end walls; three chromatophores (rarely 2) making 1.5 to 5 turns; conjugation scalariform, tubes formed by both gametangia; fertile cells enlarged to 41μ, length 71 to 172μ; zygospores ellipsoid to cylindric-ellipsoid, 30–39μ x 62–92μ; median spore wall composed of two layers, the outer layer wrinkled, the inner layer finely scrobiculate, yellow-brown at maturity.

U. S.: Florida, Miami Beach and Winter Park.

This species is at first attached to various underwater objects in flowing water

Spirogyra notabilis sp. nov.

Vegetative cells 30–37μ x 92–230μ, with plane end walls; chromatophores 2, 3, or 4 making 1 to 3 turns in the cell; at conjugation the cell walls are notably thickened; conjugation scalariform between short gametangia, tubes formed by both cells, but more by the male; receptive gametangia enlarged near the spore; zygospores ovoid 48–57μ x 78–105μ, median spore wall of two yellow-brown layers, of which the outer is conspicuously punctate, the inner reticulate and finely verrucose.

U. S : Texas, Austin, April 19, 1938.

The layers of the median wall are distinct, and among the most beautifully ornamented walls in the genus.

Spirogyra texensis sp. nov.

Vegetative cells 50–55μ x 90–530μ with plane end walls; 3 to 5 chromatophores making 1.5–3.5 turns in the cell; conjugation scalariform, tubes formed by the male gametangia; fertile cells shortened and enlarged; zygospores ovoid, 66–76μ x 99–124μ, outer spore wall transparent irregularly corrugate, median wall yellow-brown, conspicuously reticulate.

U. S.: Texas, Karnac, April 27, 1938.

Mougeotia opelousensis sp. nov.

Vegetative cells 25–28μ x 150–340μ, chromatophores with 6–12 pyrenoids in a single row; conjugation scalariform, zygospores short cylindric, with concave ends and sides, formed in the tubes, 55–64μ x 30–34μ; median spore wall yellow punctate, punctations about .8μ in diameter and evenly spaced over the entire wall.

U. S.: Louisiana, Opelousas, 1938.

Zygogonium pectosum sp. nov.

Vegetative cells 9–12μ x 12–108μ with two pillow-shaped chromatophores, sometimes elongate with flat ends; conjugation scalariform and lateral, zygospores formed in the greatly enlarged tubes; zygospores globose or subglobose (15–) 20–25μ x 18–25μ with a smooth slate blue wall; aplanospores cylindric ovoid, 9–10μ x 12–16μ, also slate blue; sporangium outer wall a 2–4μ layer of pectic compound. During conjugation the cells elongate and the walls change to pectic compounds and become greatly thickened.

U. S.· Louisiana, near Hornbeck on wet seepage slopes, April, 1938.

Zygogonium punctatum sp. nov.

Vegetative cells 9–12μ x 30–45μ with two small irregularly globose chromatophores; conjugation scalariform between gametangia that have elongated up to 115μ; zygospores globose or subglobose 18–27μ x 21–32μ, enclosed by a distinct sporangium wall; median spore wall yellow to yellow-brown, punctate.

U. S.: Louisiana, De Ridder, on roadside seepage slopes, April, 1938.

---

[1] Papers from the Department of Botany, Ohio State University, No. 473.

NOTES ON LEAFHOPPERS WITH DESCRIPTIONS (HOMOPTERA: CICADELLIDAE)

DOROTHY J. KNULL
Ohio Biological Survey
The Ohio State University
Columbus, Ohio

Xestocephalus superbus (Prov.)

Deltocephalus superbus Provancher, L., Petite Faune Entomologique du Canada, Hémiptères, Homoptères, Additions et Corrections, p. 339, 1890.
Xestocephalus fulvocapitatus Van Duzee, E. P., Bul. Buffalo Soc. Nat. Hist. 5: 215–16, 1894.

The following is a translation of Provancher's description:[1]

"Length .19 inch. Varied with brown and yellow; the vertex brown with numerous small pale-yellow or white spots, the edge brown with three yellow dots, the front yellow. Prothorax and scutellum brown with yellow dots or small yellow lines, the scutellum bearing four of them, two close to the base and two before the apex. Elytra pale with brown spots, the base with yellow lines in the brown. Below and legs yellow, back of the abdomen brown.—Cap. Rouge.

"Its variety of colors gives it an entirely pleasant appearance."

This description applies very aptly to fairly common, well-marked insects, with definite although sometimes faint, markings on vertex, pronotum and scutellum. Provancher's description applies more fully to males, and Van Duzee's description of *fulvocapitatus* is very accurate for females.

The inner male genitalia are also distinct in this species; the style has a broad foot, and aedeagus is stout with a long slender pair of processes.

Xestocephalus provancheri n. sp.

This slender unmarked species has been confused with the preceding from which it is readily separated by a lack of definite anterior markings and by the characters of the inner male genitalia.

A brown species with unmarked produced vertex which runs to *X. superbus* (Prov.) in Peters' key.[2]

Head narrower than pronotum, a little less than twice as wide as long, an eighth longer at middle than next to eye, strongly produced. Pronotum one-fourth longer than vertex, a little more than twice as wide as long, elytra long and slender, strongly exceeding abdomen.

Vertex, pronotum and scutellum yellowish brown, eyes dark, area below eyes on pronotum darkened, scutellar basal angles dark, area around ocelli light. Elytra semihyaline with opaque white patches over costal plaque, dark areas on costal margin, one at middle, another above apical cell, a square area below apex of clavus, and apical cells. Below, face and legs pale, venter and dorsum dark, usually darker in female.

Male, aedeagus with short pair of processes reaching about half length of shaft and style with narrow foot. Female last ventral segment more than twice as long as broad, almost straight, slightly notched at middle, pale spines of pygofer not as abundant as in other species, ovipositor exceeding pygofer.

Length: male, 3 mm.; female 3.25 mm.

Male holotype, female allotype and three paratypes, Columbus, Ohio, May 19, 1938, D J. & J. N. Knull, Collectors. Paratypes from Ohio: Franklin Co., July 14, 1942; Clifton, June 14, 1938; Delaware Co., June 20, 1943; and Hocking Co., May 25, 1938, and June 3, 1943, D. J. & J. N. Knull; Madison Co., Sept. 7, 1931, E. P. Breakey; Ironton, May 26, 1898, H. Osborn Collection. Paratypes from other states: Maud, Texas, April 29, 1941, D. J. & J. N. Knull; Gainesville, Fla., April 7, 1924, T. H. Hubbell; Agr. College, Miss., May 5, 1921, and Longview, Miss., April 9, 1921, A. McIntosh.

---

[1] Kindly checked by Professor Wencel J. Kostir.

[2] Peters, H. T., J. Kans. Ent. Soc. vi: 73–4, 1933.

All type material is in the Ohio State University Collection.

Xestocephalus tucsoni n. sp.

Robust, markings of vertex, pronotum and scutellum dark brown to black on tan background; elytra largely semihyaline with dark brown clouding, two inner claval veins conspicuously white toward sutural margin and near humeral angle. Inner male genitalia readily separate it from all other species as there are two pairs, instead of the usual one pair of spines on the aedeagus.

Head narrower than pronotum; vertex more than three times as broad as long, twice as long at middle as next to eye, slightly produced; pronotum more than half longer than vertex, two and three-eighths times as wide as long, humeral and lateral margins equal; elytra exceeding abdomen. Tarsal claws straight, curved ventrad.

Dark brown irregular mottling on vertex and pronotum, light and dark areas covering about equal amounts of surface, scutellum very dark, with a bluntly triangular basal white spot either side of middle and on mid-lateral margins. Elytra semihyaline, dark dorsum of insect showing through to give them a dark cast, claval veins whitened as mentioned above, square area below apex of clavus brown, corium largely semihyaline with some rounded hyaline spots margined with brown and small brown areas at ends of apical veins. Face brownish black with trace of pale arcs on front, on upper part a dark bat-shaped figure enclosed by light area. Venter very dark, legs lighter.

Male, aedeagus differing from that in all other species in having two pairs of latero-ventral processes, the outer pair longer; style with broad foot, rounded apex toothed on inner half of margin. Female, last ventral segment more than twice as long as preceding, posterior margin with sides sloping faintly up toward middle where there is a minute notch at the base of a slit which extends almost half length of segment. Pygofer dark brown, apex of ovipositor darker, exceeding pygofer, sides of pygofer with profuse, long, stout, tan spines.

Length: male, 3.2 mm.; female 3.5 mm.

Holotype male and allotype female from Tucson, Arizona, collected July 12, 1937, by D. J. & J. N Knull, and deposited in the Collection of The Ohio State University.

Stirellus osborni n. sp.

The smallest, darkest member of the genus.

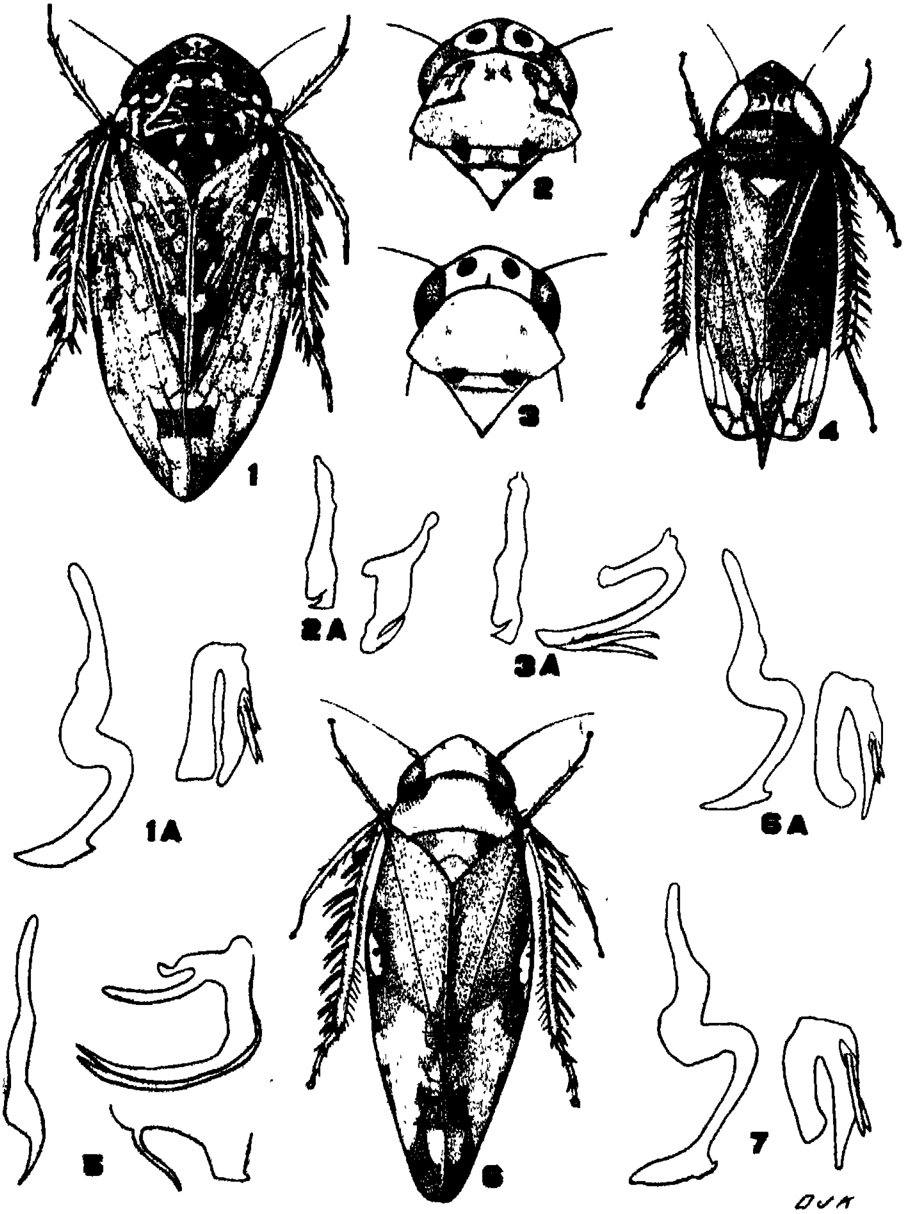
Head as wide as pronotum; vertex a little longer at middle than width between eyes, half longer at middle than next to eyes, eyes large. Pronotum two and one-half times as wide as long, as long as vertex at middle, lateral margins very short, humeral margins long, posterior margin transverse, disc transversely striate especially on posterior two-thirds; elytra exceeding abdomen in male, exceeded by apex of ovipositor in female.

Female, uniform rich brown with the following light areas: a spot at apex of vertex, traces of light pattern on disk and base; pronotum, indication of median longitudinal stripe, apex of scutellum; elytra, claval veins and elytral area extending from above inner apical cell, obliquely

---

EXPLANATION OF PLATE

1. *Xestocephalus tucsoni* n. sp., female; 1A. Inner male genitalia, lateral view of style and aedeagus.
2. *Erythroneura apacha* Baker, female; 2A. Inner male genitalia, lateral view of style and aedeagus.
3. *Erythroneura balli* Beamer, female; 3A. Inner male genitalia, lateral view of style and aedeagus.
4. *Stirellus osborni* n. sp., female.
5. *Dikraneura mera* McAtee, inner male genitalia, lateral view, style, aedeagus and posterior margin of ninth segment.
6. *Xestocephalus provancheri* n. sp., female; 6A. Inner male genitalia, lateral view of style and aedeagus.
7. *Xestocephalus superbus* (Prov.), inner male genitalia, lateral view of style and aedeagus.



Note: Figs. 1, 4 and 6 to same scale; 2 and 3 to same scale; and all illustrations of inner male genitalia to same scale.

on anteapicals, to costal margin, apical cells dark and veins embrowned. Male, uniformly dark but for pale apex of scutellum, below dark in male, in female with white ocelli and oval pale area just below clypeal suture; spines of legs pale in both sexes.

Female, last ventral segment about as long as penultimate, posterior margin slightly concave; ovipositor exceeding pygofer by twice its width; a few pale spines on pygofer. Male, genitalia similar in form to those of *S. bicolor* (V. D.) as illustrated,[3] except that the pygofer extends beyond the plates by more than half their length.

Length: male, 2.5 mm.; female 3 mm.

Holotype female, allotype male and eight female paratypes collected near Homestead, Fla., Feb 16, by Herbert Osborn and in the Osborn Collection at The Ohio State University.

Named for Professor Herbert Osborn, collector of the type series.

Dikraneura mera McAtee

Proc Ent. Soc. Wash. 26: 76, 1924.

This species was described from a single female from Maryland taken on white oak. A number of specimens has been taken from white oak in Tennessee and Ohio, and since the male has not been described, a figure of the inner male genitalia is presented, and a male specimen, Delaware Co., Ohio, August 27, 1942, D. J. & J. N. Knull, is made the allotype and placed in the collection of the author.

Dr. P. W. Oman kindly compared specimens with the type and assured me that they were correctly identified. In McAtee's description he indicates that the clavus is black. This is not true in any of the specimens I have at hand, and Dr. Oman did not mention that it is true of the type.

Erythroneura apacha Baker

Typhlocyba bipunctata Gillette, *Proc. U. S. Nat. Mus.* 20: 751, 1898.

Erythroneura apacha Baker, nom. nov. for *E. bipunctata* Gill., *The Philipp. J. of Sci.* 27: 537, 1925.

Dr. D. M. DeLong has recently compared female specimens taken by D. J. & J. N. Knull near Tucson, Arizona, with the female (wingless) type of *E. apacha* Baker, in the U. S. National Museum, and has noted that the markings are "just like the type." Specimens were taken at light and from a low-growing *Acacia* in the Tucson Mts., and in Sabino Canyon on a number of occasions on dates ranging from May 13 to August 27. A study of the inner male genitalia shows them to be quite distinct from those in Dr. Beamer's *E. balli* (*J. Kans. Ent. Soc.* 5: 125, 1932) which he later (*Can. Ent.* 66: 175, 1934) made a synonym of *E. apacha* Baker.

It is my belief that *E. apacha* Baker and *E. balli* Beamer are separate and distinct species, and illustrations are offered to show their differences. Specimens determined by Dr. Beamer are at hand.

---

[3] Thomas, Ruth L., J. Kans. Ent. Soc. vi: 136, Pl. II, 1933.

Methods of Plant Breeding

Although designed for use in advanced undergraduate and graduate classes in plant breeding this book is somewhat more than a classroom textbook. It is in addition a reference work on the methodology and genetics applicable to programs of crop-plant improvement.

The genetic basis and the methods and technics of improvement by hybridization and selection are thoroughly treated for all our crop plants. The chapters dealing with approved methods of field-testing new varieties or strains for yield are excellent.

Throughout, the discussion centers around illustrative examples from the literature and from the extensive research carried on by the authors and their students.

The text proper is supplemented by a list of over four hundred references, statistical tables useful in analysis, and a glossary consisting mostly of general botany and elementary genetic terminology.

The book is sturdily bound and the type is easily read. In this reviewer's opinion, a few more illustrations would be a decided improvement.—*R. T. Wareham.*

Plant Breeding, by Herbert Kendall Hayes and Forrest Rhinehart Immer. 432 pp. New York, The McGraw-Hill Co., 1942. $4.00.

NOTES ON ZYGNEMATACEAE[1]

E. N. TRANSEAU
The Ohio State University
Columbus, Ohio

During the past year an effort has been made to revise my keys to the genera and species of the Zygnemataceae. Many old specimens have been re-examined and many new collections have been studied. As a result of these investigations the following changes in specific designations are proposed, and four new species are described.

Spirogyra triplicata (Collins) comb. nov.
=*S. decimina* var. *triplicata* Collins 1912.
Phycotheca Bor.-Amer. No. 960; also Green Algae of North America, p. 110.

Spirogyra tropica (G. S. West) comb. nov.
=*S. decimina* var. *tropica* W. & G. S. West 1901.
Flora of Koh Chang, Bot. Tidsskr. 24: 161.

Spirogyra bichromatophora (Randhawa) comb. nov.
=*S. gallica* var. *bichromatophora* Randhawa 1938.
Proc. Indian Acad. Sci. 8: 353.

Spirogyra minor (Schmidle) comb. nov.
=*S. malmeana* var. *minor* Schmidle 1901
Hedwigia 40: 47.

Spirogyra prescottii (Prescott) comb. nov.
=*Spirogyra collinsii* var. *minor* Prescott 1942.
Amer. Midland Naturalist, 27: 673, Pl. 4, Fig. 15–17.

Spirogyra regularis (Cedercreutz) comb. nov.
=*Spirogyra reticulata* var. *regularis* Cedercreutz 1924.
Acta. Soc. pro Fauna et Flora Fennica 55, No. 2, p 3.

Spirogyra taftiana sp. nov.

Vegetative cells 18–25μ x 50–96μ with plane end walls, one chromatophore making 2-4 turns in the cell; conjugation scalariform, tubes formed by both gametangia; receptive gametangia enlarged or fusiform inflated; sterile cells often bulliform; zygospores ellipsoid 24-34μ x 42–80μ, median wall yellow, distinctly and densely punctate, pits more or less angular.

Huntsville, Texas (C. E. Taft Collection).

Spirogyra visenda sp. nov.

Vegetative cells 40–45μ x 130–150μ, with plane end walls; one narrow chromatophore making 4–9 turns in the cell; conjugation scalariform, with broad tubes formed wholly by the male gametangia; receptive gametangia inflated to 60–80μ; zygospores ellipsoid, sometimes ovoid 55–65μ x 92–124μ, median spore wall yellow, smooth.

Columbus, Missippi, April 14, 1925.

Both gametangia are reflexed and the conjugating pairs are separated by vegetative cells.

Sirogonium melanosporum (Randhawa) comb. nov.
=*Sirogonium ventersicum* var. *melanosporum* Randhawa 1938, Proc. Indian Acad. Sci. 8: 364.

Sirogonium pseudofloridanum (Prescott) comb. nov.
=*Spirogyra pseudofloridanum* Prescott 1944, Farlowia 1: 360-361, Fig. 1.

---

[1] Papers from the Department of Botany of the Ohio State University No. 472.

Sirogonium megasporum (Jao) comb. nov.
=*Sirogonium sticticum* var. *megasporum* Jao 1935, Sinensia 6: 645, Pl. 12.

Sirogonium hui (Li) comb. nov.
=*Spirogyra hui* Li 1938, Bull. Fan Inst. Biol., Bot. Ser. 8: 91.

Zygnema cylindrospermum comb. nov.
=*Z. stellinum* var. *cylindrospermum* W. & G. S. West 1905.
Transac. & Proc. Bot. Soc. Edinburgh 23: 3–40, Pl. 1, Fig. 2–5.

Zygnemopsis orientalis comb. nov.
=*Debarya desmidioides* var. *orientalis* Carter 1926.
Records Bot. Survey of India 9: 281.

Zygnemopsis tiffaniana comb. nov.
=*Debarya cruciata* Price 1911. New Phytologist 10: 87; idem 11: 60.
Also *Zygnemopsis cruciata* (Price) Transeau 1934, and *Mougeotia cruciata* (Price) Czurda 1932.

Debarya ackleyana sp. nov.

Vegetative cells 12–15μ x 90–140μ with a single ribbon-like axile chromatophore with about 8 pyrenoids; conjugation scalariform, tubes long and slender at first, later the median spore wall becomes rounded and the sporangium wall is perfectly distinct; zygospore golden yellow mostly compressed globose, sometimes ovoid, 50–54μ x 52–65μ, median wall tricarinate, the lateral keels finely ruffled and very distinct, with corresponding corrugations between the keels; the middle keel thin, radially striate and up to 10μ wide; polar walls obscurely pitted and without a "hub."

U. S.: Michigan (Ackley Coll.), Massachusetts (Bullard Coll.).

Named for Dr. Alma Ackley of Wayne University who collected the type specimens near Douglas Lake, Michigan.

Mougeotia africana comb. nov.
=*Debarya africana* G. S West 1907. Jour. Linn. Soc. Bot. 38 104, Pl. 5, Fig. 3.

Mougeotia rava sp. nov.

Vegetative cells 8–12μ x 30–120μ, chromatophore with 4 to 8 pyrenoids in a row; reproduction by aplanospores which are formed mostly outside the recurved sporiferous cells; aplanospores globose 16–20μ in diameter, median wall gray-brown and smooth.

U. S.: Mississippi, Starkville; Louisiana, Alexandria (Hicks Coll.); Texas, Austin (Taft Coll.).

This species resembles *M. calcarea*, but differs in being aplanosporic and having gray-brown spores.

Practical Malaria Control

This pocket-sized manual for the control of malaria is well described by its title and subtitle given below. It is an abbreviated treatise, yet many items appear which are new, and some are considered in detail. The subject matter is treated very systematically and is divided into four parts: 1, Antimalarial Measures; 2, Diagnosis; 3, Treatment; and 4, Complications of Malaria.

The author, both an entomologist and a physician, has spent many years in the tropical jungle of New Guinea where malignant tertian malaria is highly endemic. People concerned with the control of malaria in similar situations should find this book to be a great help, although its use is not restricted to such areas.

The publisher, it is assumed, is responsible for printing the book on undesirable paper and without a table of contents and index. Also, the price is large for the size of the book. These facts are mentioned because they should not deter one from purchasing this manual for the excellent contribution the author has made to the literature on control of malaria.

Practical Malaria Control. A handbook for field workers, by Carl E. M. Gunther. 91 pages, 1944. Philosophical Library, Inc., 15 East 40th St., New York, N. Y. Price, $2.50.

THE OHIO JOURNAL OF SCIENCE

VOL. XLIV NOVEMBER, 1944 No. 6

STUDIES IN HODGKIN'S SYNDROME

I. A DISTRIBUTION STUDY OF HODGKIN'S DISEASE IN THE UNITED STATES

H. A. HOSTER
With the Technical Assistance of
F. W. SHEPARD AND L. H. HATTON[1]

Although much has been said about the part played by many infectious agents in the etiology of the disease entity described by Thomas Hodgkin[3] in 1832, no satisfactory statistical surveys have appeared relative to its comparative distribution in communities, states, and countries; in rural and urban populations; and in different races and climates. Information relative to the geographic and racial distribution of disease has become of increasing importance to the American physician as he himself has become migratory or as his patients may now come to him from a sojourn anywhere in the world. The possible nature of the as yet undetermined etiology of certain well established disease syndromes may be suggested by such surveys, and for this reason the present analysis was begun some two years ago as a part of an intensive study of the very considerable range of clinical and pathologic states grouped under the general designation of Hodgkin's disease. It must be said, however, that just as Thomas Hodgkin in his original report presented a series of cases, which were later recognized by careful microscopic study to comprise lymph node pathology of divergent underlying etiologies, so we, at the present time, are not certain that all of the histopathological abnormalities grouped under the heading of Hodgkin's syndrome are necessarily due to the same etiologic agent. A classification and re-emphasis of the range of clinical and histological findings observed in Hodgkin's disease has recently been presented by Jackson and Parker.[4] It is interesting to note that, just as in similar previous analyses by other workers, there is again noted a very wide variation in both clinical and histopathological patterns grouped under the general term Hodgkin's disease; from a relatively benign "infectious" granuloma on the one hand to an invariably fatal sarcoma on the other.

The presence in Hodgkin's tissue of mycobacteria, diphtheroids, amoebae, fungi, common bacterial invaders of the upper respiratory tract, small, gram-positive, anaerobic, gas-forming rods, Brucella, and viruses has been reported in the literature. Most of the infectious agents isolated have been subsequently discarded as etiologic factors because of their failure to produce the clinical and histopathological picture of Hodgkin's disease in experimental animals, and because of conflicting and irreconcilable reports from diverse sources. Due, however, to the nature and chronicty of the clinical course, the location and granulomatous character of the lesions, and the actual demonstration of acid fast organisms in some cases, the tubercle bacillis has remained under suspicion since Sternberg's first report[5] and has been the subject of many subsequent investigations. A few among those who have adduced direct or circumstantial evidence as to its possible causal relationship to Hodgkin's disease are Sternberg,[5] Lichtenstein,[6] Fraenkel and Much,[7] L'Esperance,[8] and Stewart and Doan.[9] On the other hand, van Rooyan,[10] Twort,[11] Branch,[12] Reed,[13] Longcope,[14] Terplan and Mittelbach,[15] Uddstromer,[16] Jackson and Parker,[4] and others have expressed their unwillingness to accept this etiologic relationship. Classical tuberculous lesions have been demonstrated at post mortem in association with lesions typical of Hodgkin's disease in about twenty to thirty per cent of deaths attributed to the latter. When one considers conversely, however, the incidence of Hodgkin's disease in patients with proven clinical tuberculosis the correlation is found to be much lower. Medler is reported by Jackson and Parker[4] to have found that only 0.3 per cent of a large series of tuberculous patients examined at autopsy showed the histopathological changes of Hodgkin's disease; and Uddstromer[16] has reported that in Sweden the occurrence of Hodgkin's granuloma in areas where the incidence of tuberculosis is high, was actually less than in areas where the latter was low.

---

[1] Hodgkin's disease research carried on in the Division of Research, Department of Medicine, Ohio State University, is made possible in part by the Elise S. L'Esperance Fellowship Fund and by the Comley Research Fund.

[2] The maps representing the incidence of avian tuberculosis and Bang's disease in cattle are printed with the consent of the U. S. Department of Agriculture.

[3] Hodgkin, Thomas. "On Some Morbid Appearances of the Absorbent Glands and Spleen." Tr. Roy. Med. Chir. Soc., Vol. 17, 1832, pp. 68–114.

[4] Jackson, H., Jr. and Parker, F. Jr. New Eng. Journ. of Med., Vol. 230, No. 1, Jan., '44, pp. 1–8.

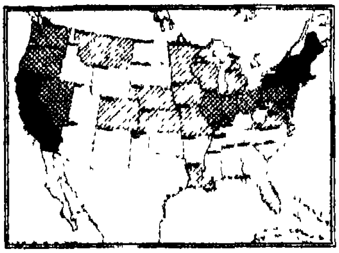
The suggestion made by L'Esperance that Hodgkin's syndrome may be caused by an avian tubercle bacillus[8] or an atypical mycobacterium[17] of hitherto unrecognized pathogenic importance renders a comparison of human tuberculosis with Hodgkin's disease of less significance, since the incidence of atypical infections due to strain of acid fast bacilli other than human and bovine pathogens does not follow or parallel the incidence of human pulmonary tuberculosis.

Parsons and Poston[18] and Forbus[19] have recently reported the isolation of organisms of the Brucella group from patients with typical Hodgkin's lesions, but no convincing confirmation of their very interesting and suggestive observations has as yet been published.

The incidence of Hodgkin's disease among all post mortem examinations done at general hospitals is given by Symmers[20] as 0.16%; Barron,[21] 0.32%; Ciechanowski,[22] 0.33%; and Jackson and Parker,[4] 0.25%.

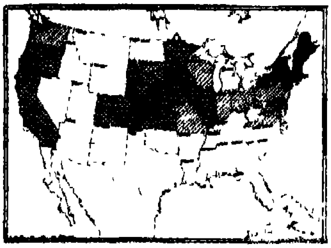
---

[5] Sternberg, C. Ztschr. f. Heilk 19: 21, 1898.
[6] Lichtenstein, A. Frankfurt Ztschr. f. Path. 24: 29, 1921.
[7] Fraenkel, E., and Much, H. Ztschr. f. Hug. u. Infekt. 67: 159–200, 1910; 99: 391, 1923.
[8] L'Esperance, E. S. J. Immunol. 16: 27–36, Jan., 1929; 16: 37–60, Jan., 1929.
[9] Stewart, F. W., and Doan, C. A. Annals of Surg., p. 141–52, 1931.
[10] van Rooyen, C. E. Brit. Med. Jour. 1: 50–51, Jan. 14, 1933.
[11] Twort, C. C. Journal Path. and Bact., Vol. 33: 539–546, July, 1930.
[12] Branch, A. Arch. Path. 12: 253–274, August, 1931.
[13] Reed, D. M. J. H. H. Rep. 10: 133, 1902.
[14] Longcope, W. T. Bull. Ayer Clin. Lab. Penn. Hosp. 1:1, 1903.
[15] Terplan, K., and Mittelbach, M. Virchows Arch. f. Path. Anat. 271: 759–866, 1929.
[16] Uddstromer, M. Acta. Tuberc. Scandinav., supp. 1, pp. 1–225, 1934.
[17] L'Esperance, E. S. Personal Communication.
[18] Parsons, P. B., and Poston, N. A. South Med. Jour. 32: 7–13, Jan., 1939.
[19] Forbus, W. D., and Gunter, J. U. South Med. Jour. 34: 376, 1941.
Forbus, W. D. Am. J. Path., Vol. 18, No. 4, July, 1942.
[20] Symmers, D. Arch. Int. Med. 4: 218, 1909; Arch. Int. Med. 21:237, Feb., 1918; Am. J. Med. Sci. 167: 313–339, March, 1924; Am. J. Med. Sc. 174: 9–29, July, 1927.
[21] Barron, M. Arch. Path and Lab. Med. 2: 659–690, Nov., 1926; J. A. M. A. 87: 1445, 1926.
[22] Ciechanowski, S. Virchows Arch. f. Path. Anat. 303: 206–222, 1938.



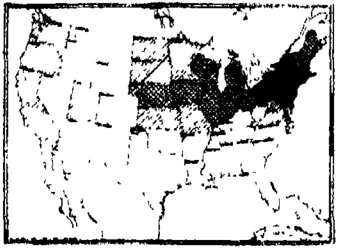
DISEASES OF THE HEART

1941



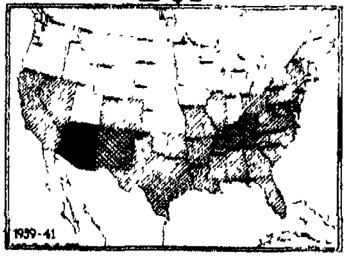
HODGKINS DISEASE MORTALITY

1939-41

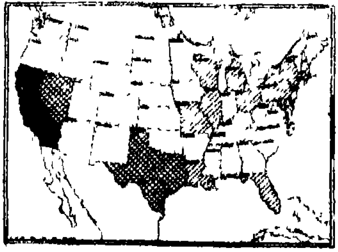


DIABETES MELLITUS

1939-41

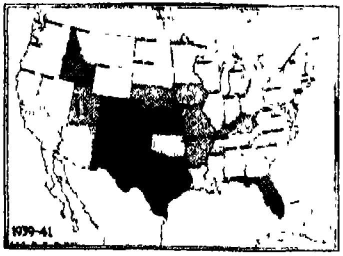


TUBERCULOSIS CASE MORTALITY

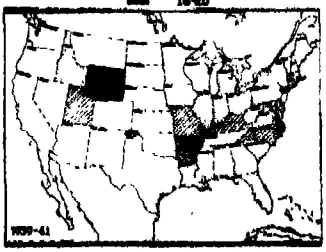


CIRRHOSIS OF THE LIVER

1939-41

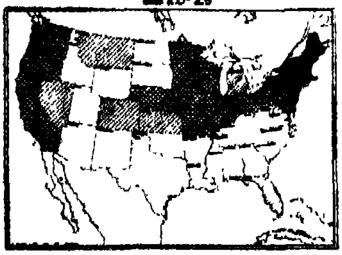


BRUCELLOSIS CASE MORTALITY



TULAREMIA

MORTALITY PER 100,000



CANCER AND OTHER MALIGNANT TUMORS

1941

METHODS

All the data concerning mortality between the years 1939 and 1941 presented in the accompanying charts (Plates I and II) were furnished by Dr. Halbert L. Dunn, Chief Statistician for Vital Statistics, Bureau of Census, Washington, D. C. No data previous to the year 1939 were used because of the revision in the International List of Causes of Death in respect to Hodgkin's Disease during the preceding year. "In 1938 the International List was revised and, effective in 1939 and thereafter, the conditions accepted for tabulation as Hodgkin's Disease were narrowed down to include only Hodgkin's Disease, Lymphatic Anemia, Lymphogranuloma, Lymphogranulomatosis, Pseudoleukemia (only when mentioned in connection with Hodgkin's disease)."[23]

Statistics concerning the incidence of brucellosis and avian tuberculosis in animals (Pl. III) were obtained from the U. S. Department of Agriculture. The data representing mortality per hundred thousand in each disease entity were treated in two ways:

1. Maps (Pl. I) were compiled showing distribution by means of five gradations of the degree of positive incidence, represented by pure white, stippled, single cross hatch, double cross hatch, and solid black in order of increasing magnitude.

2. Another series of companion charts (Pl. II) were compiled using bars of forty-nine lengths to represent the relative order of magnitude of each state among its sister states and the District of Columbia. All states with a zero mortality in a given map are represented as first in order of increasing frequency. Similar statistics for heart disease, diabetes, cirrhosis of the liver, cancer, and other malignant tumors, and tularemia were selected for comparison and contrast.

RESULTS

A consideration of the data available for Hodgkin's disease (Pls. I and II) reveals that its greatest reported mortality is in the state of Maine. The coastal and north central states show a rather high mortality, the actual number of cases reported in the northern half of the United States being almost twice that observed in the southern half. The distribution of human tuberculosis (Pls. I and II) is entirely dissimilar; in fact, the general areas in which tuberculosis mortality is greatest are areas in which Hodgkin's disease is reported least often. The distribution of avian tuberculosis in fowl (U. S. D. A., 1931) (Pl. III) seems to be only remotely similar to Hodgkin's disease. A map issued by the U. S. D. A. in 1941 (Pl. III) is even less suggestive. The distribution of brucellosis mortality in man (Pls. I and II) is very unlike that of Hodgkin's disease; and consideration of the incidence of Bang's disease in cattle (U. S. D. A., 1941) (Pl. III) reveals no parallel to human brucellosis mortality or to Hodgkin's disease. A comparison of the population ratio of white versus other races (Pl. III) to Hodgkin's disease, diabetes, mellitus, heart disease, and neoplastic disease (Pls. I and II) reveals some similarity. The control maps, with the possible exception of cirrhosis of the liver and tularemia, bear an apparent resemblance to themselves and to Hodgkin's disease.

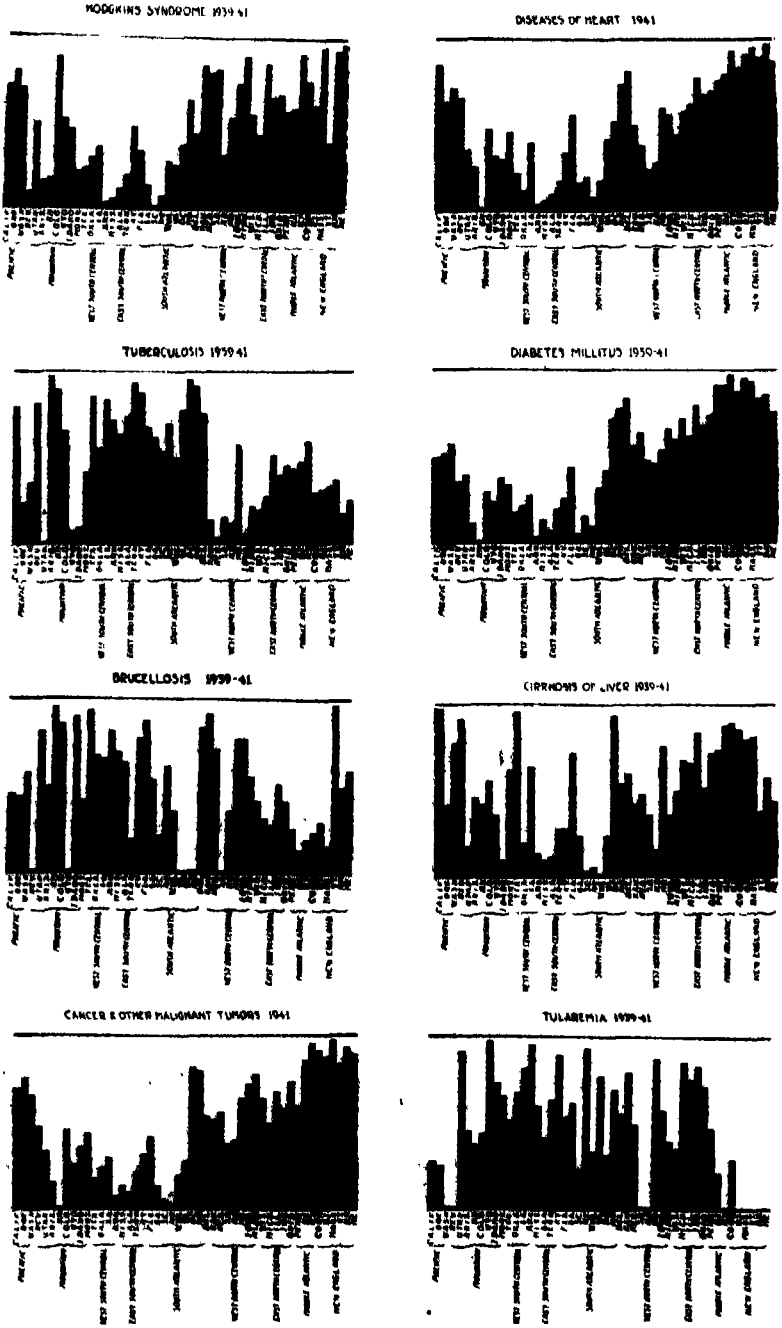
In a study of this type it is appreciated that there are many sources of error. A few of these may be stated as follows: differences in economic level; in population ratio of white versus other races; in medical acumen, in opinion as to diagnostic criteria, in availability of diagnostic facilities, and in migration across state borders.

---

[23] Dunn, Halbert L. Personal Communication.

Hodgkin's Disease
H. A. Hoster

PLATE II



HODGKINS SYNDROME 1939-41

DISEASES OF HEART 1941

TUBERCULOSIS 1939-41

DIABETES MILLITUS 1939-41

BRUCELLOSIS 1939-41

CIRRHOSIS OF LIVER 1939-41

CANCER & OTHER MALIGNANT TUMORS 1941

TULAREMIA 1939-41

DISCUSSION

Among those diseases selected for study, the dispersion of Hodgkin's mortality data seems to resemble more closely those entities belonging to the so-called degenerative, metabolic, and constitutional inheritance groups. The inclusion of malignancy does not in our opinion necessarily constitute evidence in favor of a neoplastic etiology for all Hodgkin's disease. It is the opinion of the majority of students of the subject that Hodgkin's granuloma appears to be a non-malignant process, probably of infectious origin, and this concept is shared by us. A consideration of our own clinical material and a review of the literature points to the suggestion that Hodgkin's syndrome may result from the activity of one or more co-active infectious agents of more or less general distribution, and that definite localizing or precipitating factors such as allergy, non-specific infection, injury, constitutional and endocrine factors may be concerned in the development of the lesion. The claim for malignancy in Hodgkin's syndrome hinges on many equivocal points, namely, that the Sternberg-Reed cell is a neoplastic cell seen only in the presence of the Hodgkin's process, that invasiveness is a quality of malignancy, that the progressive character of the disease suggests malignancy, and that since the disease has not been reproduced in an experimental animal, it is not caused by an infectious agent or agents. A careful consideration of the clinical and histological picture of Hodgkin's granuloma is the most convincing evidence of the tenuous nature of these claims. A few of the arguments which militate against a neoplastic etiology are the pleomorphic character of the cellular lesions, the abundance of scar tissue formation which frequently replaces the original cellular reaction, the peculiar relapsing type of fever and tachycardia, the relative frequency of initial adenopathy in the cervical region, and the frequent spontaneous disappearances of enlarged lymph nodes without any form of therapy.

A consideration of the combined age distribution data of individuals with Hodgkin's granuloma observed by Jackson and Parker,[4] Uddstromer,[14] and ourselves[24] reveals the fact that the onset of "granulomatous" Hodgkin's disease occurs with a somewhat similar frequency at all ages. There is a moderate rise from the first to the third decade and an even less pronounced fall thereafter to the seventh decade. The sarcomatous type, however, is seen very infrequently before the age of twenty, and occurs with greatest frequency between the ages of fifty and seventy. It is felt that a clinical and pathological disease syndrome such as Hodgkin's granuloma with a frequency distribution extending throughout the life span should not be considered in the same etiological group with presumably neoplastic disease syndromes such as Hodgkin's sarcoma.

SUMMARY AND CONCLUSION

The dispersion pattern of Hodgkin's disease mortality is compared with the mortality of human tuberculosis and brucellosis and the incidence of fowl tuberculosis and bovine brucellosis. Certain unrelated diseases of diverse etiology are reviewed for comparison.

The fact that the majority of available evidence in the case of Hodgkin's disease favors an infectious etiology is re-emphasized.

---

[24] Hoster, H. A. Unpublished data.

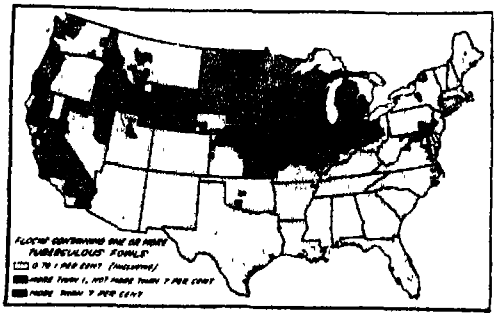

FLOCKS CONTAINING ONE OR MORE TUBERCULOUS FOWLS
0 TO 1 PER CENT (INCLUSIVE)
MORE THAN 1, NOT MORE THAN 7 PER CENT
MORE THAN 7 PER CENT

FIGURE 1 – Approximate extent of avian tuberculosis in the United States

AVIAN TUBERCULOSIS
1931

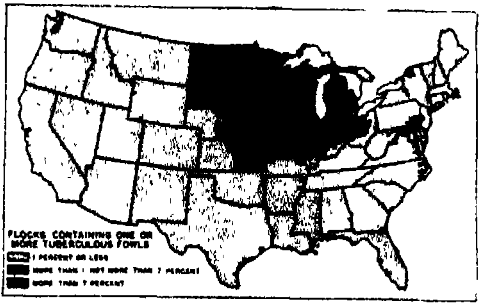

FLOCKS CONTAINING ONE OR MORE TUBERCULOUS FOWLS
1 PERCENT OR LESS
MORE THAN 1 NOT MORE THAN 7 PERCENT
MORE THAN 7 PERCENT

FIGURE 3 – Approximate extent of avian tuberculosis in the United States on January 1, 1941

AVIAN TUBERCULOSIS

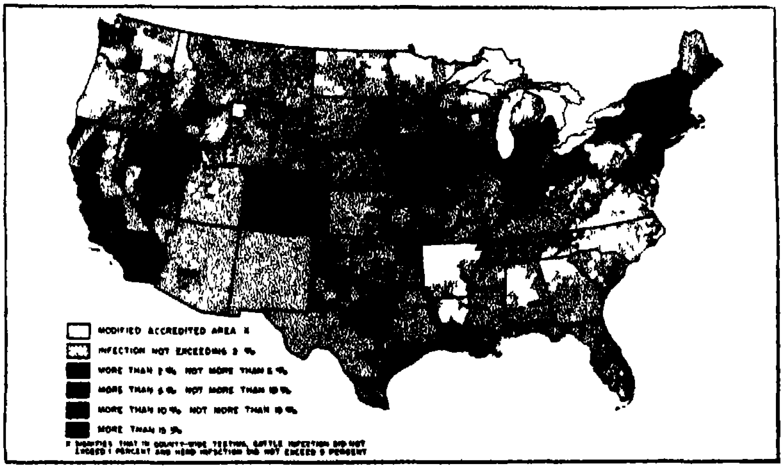
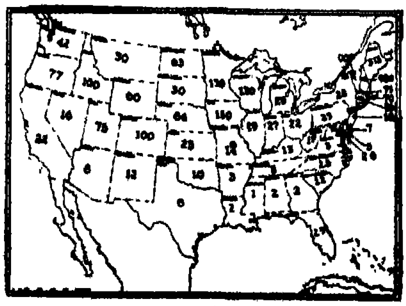
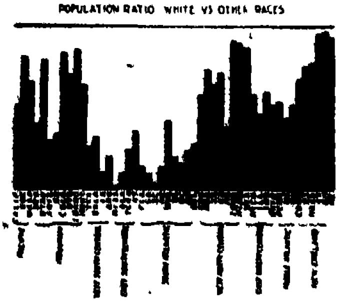

MODIFIED ACCREDITED AREA *
INFECTION NOT EXCEEDING 2 %
MORE THAN 2 % NOT MORE THAN 5 %
MORE THAN 5 % NOT MORE THAN 10 %
MORE THAN 10 % NOT MORE THAN 15 %
MORE THAN 15 %
* SIGNIFIES THAT IN COUNTY-WIDE TESTING CATTLE INFECTION DID NOT EXCEED 1 PERCENT AND HERD INFECTION DID NOT EXCEED 5 PERCENT

FIGURE 2.—"Modified accredited Bang's disease-free areas" and the estimated extent of infection in the remaining counties, November 1, 1941.

BANGS DISEASE IN CATTLE, 1941
(Brucellosis)



POPULATION RATIO
WHITE — OTHER RACES



NOTES ON SOME LESS COMMON GENERA OF TROPICAL CIXIIDAE

(HOMOPTERA)

JOHN S. CALDWELL,
Circleville, Ohio

Microledrida Fowler

This genus was established for *asperata* from Guerrero in Mexico. *Fusçata* Van Duzee from California occurs in adjacent Sonora (M. F. 209, Dampf) and *fulva* Metcalf from Texas has been taken in Tamaulipas (Caldwell).

Microledrida virida n. sp.

Length 5 mm. Vertex green with three red incomplete transverse stripes; extreme apex yellow. Eyes with transverse black stripe across center. Pronotum next to vertex red; green caudad. Mesonotum yellowish to gray in center with the lateral compartments fuscous and including a black spot caudad next to the lateral carinae. Elytra clear; infuscate basad, a transverse fuscous stripe present across furcations of main veins; each apical cell with a diffused fuscous spot. Abdomen greenish.

Vertex produced, longer than mesonotum, with prominent median carina. Face extremely flat; no median carina present. Sutural margin of elytra with vertical thin plate-like projection at junction of anal vein.

Female holotype of this large species from Peten Lake, Guatemala, 11–12–25 (M. F. 734. Dampf).

Micrixia Fowler

Fowler erected this genus for the unique *costalis* from Mexico. With the addition of another species it becomes necessary to modify the original definition or erect a new genus that differs by veinational characters alone. It is my belief that these characters are more specific than generic in this case and by omitting the statement concerning the freak claval vein entering the suture at about the middle of the clavus accept the original definition which will then include the two species.

Micrixia nigra n. sp.

Length 3.2 mm. Black over all with carinae of vertex, all of pronotum, and legs smoky. Face not as narrowed as in *costalis*. Elytra with normal claval veins; medius not branched; two apical cells formed by medius and adjacent veins very long; only two subapical cells present, these formed by cubital and radial veins.

Female holotype from three miles north of Acapulco, Guerrero, 11–22–38 (Caldwell).

Diastrocixius n. gen.

Vertex deeply concave, notched caudad, carinate cephalad; sides almost parallel. Lateral carinae of vertex, frons, and clypeus greatly elevated, almost vertical above, oblique below. Frons widened to apex; median carina forked basad forming a transverse carina; median ocellus prominent. Carinae of clypeus evanescent toward apex. Caudal margin of pronotum parallel to caudal margin of vertex. Mesonotum tricarinate. Medius arising from base of subcostal-radial stock. Veins indistinctly punctate; stigma long, narrow. Hind tibiae without prominent spurs. Pygofers of female robust; ovipositor seemingly complete.

Type: *Diastrocixius thelyus* n. sp.

This genus resembles *Bothriocerodes* Fowler in general appearance but in most keys the male will run to *Cixius* from which it differs in having greatly elevated lateral carinae on the head and the two carinae between the crown and forehead are widely separated and not connected by a median carina. Fowler does not mention or show a double carinae on the forehead and in his illustrations the lateral carinae are not as elevated as in the species before me; therefore I believe *Diastrocixius* is distinct from *Bothriocerodes*. Its true placement is probably in the tribe *Pintaliini* although the elytra are not as steep as in *Pintalia*.

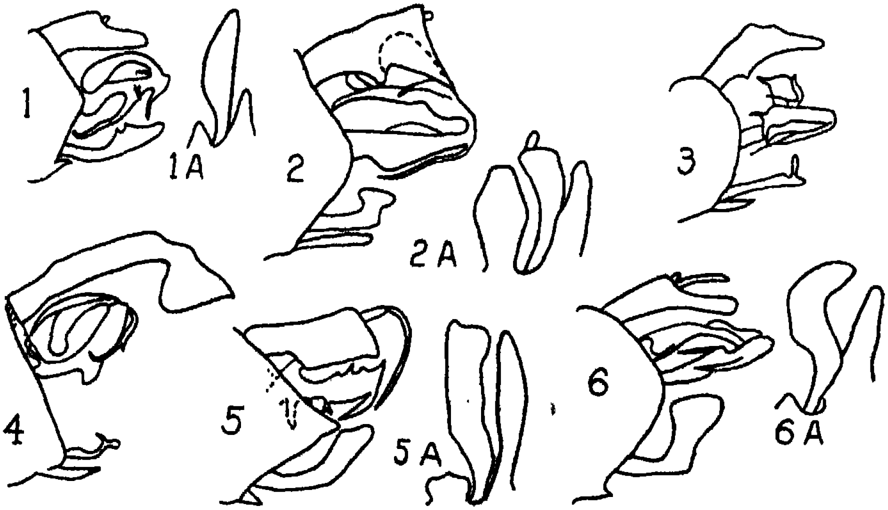
Diastrocixius thelyus n. sp.

(Figs. 1 and 1-A)

Length 6.5–7.5 mm. Eyes black, ocelli red; head and thorax yellow; abdomen sometimes red; legs yellow with apical tarsi smoky; elytra clear with yellow veins.

Median carina of frons short, visible only in basal third. Anal segment of male simple, short. Lateral margins of pygofers broadly obtuse caudad; medio-ventral process short, acute. Styles slender, lanceolate.

Male holotype, female holotype, and paratypes from Vergel, Chiapas, May and June, 1935 (M. F. 4268, 4253 and 4239), male paratype, Elzapote, Chiapas, 9–12–30 (M. F. 1821), and fifty female paratypes, Esmeralda, Chiapas, 11–18–30 (M. F. 1934 and 1937) (Dampf).



1. *Diastrocixius thelyus*. Profile of male genitalia.
1-A. Ventral aspect of right forcep and right central portion of male pygofer.
2. *Diastrocixius aurelus*. Same as 1.
2-A. Same as 1-A.
3. *Nymphocixia vanduseei* Muir. Same as 1.
4. *Rhamphixius championi* Fowler. Same as 1.
5. *Diastrocixius apicatus*. Same as 1.
5-A. Same as 2-A.
6. *Pachyntheisa concinna* var. *striata*. Same as 1.
6-A. Same as 1-A.

Diastrocixius thelyus var. **basalis** n. var.

Length 8 mm. Color as in *thelyus thelyus* except base of elytra fuscous with this color continuing caudad between claval vein and sutural margin.

Holotype female from Finca Belem, Chiapas, 3–2–38, (M. F. 6497, Dampf).

Diastrocixius aurelus n. sp.

(Figs. 2 and 2-A)

Length 6.5 mm. Head and body yellow, elytra clear with yellow veins. Median carina of frons visible in basal two-thirds; basal fork acute.

Anal segment of male with subapical projection on ventral margins; right margin cut away before apex. Lateral margins of pygofers broadly rounded caudad; medio-ventral process extremely large, as long as styles, pyriform.

Male holotype from Bartica, British Guiana, 4-27-01 (Parish), in Osborn collection at Columbus, Ohio.

Diastrocixius apicatus n. sp.

(Figs. 5 and 5-A)

Length 6 mm. Vertex and thoracic dorsum orange; abdomen black above, venter yellow. Elytra mostly clear; stigmal spot dark with color extending up onto the disc; smoky band present subapically. Under wing with fuscous apex. Entire face narrow; frons not especially widened apically; median carina interrupted only by median ocellus. Anal segment of male constricted basad. Pygofers greatly produced caudad into acute flaps; medio-ventral process short, very broad. Styles large, long; sides roughly parallel. Aedeagus appears to have periandrium separated from penis except basad.

Holotype male, allotype female, and one male paratype from Coroica, Bolivia, in the H. Osborn collection at Columbus, Ohio; one male paratype in writer's collection.

Diastrocixius magnus n. sp.

Length 7.5 mm. Face yellow with lateral carinae broadly fuscous and median carinae of frons fuscous apically. Vertex black caudad and in center. Pronotum yellow with black dash behind either eye. Mesonotum fuscous. Elytra clear with dark veins; apex slightly infuscate; sutural margin fuscous to apex of clavus. Legs smoky. Face scarcely narrowed between the eyes; median carinae of frons distinct; basal fork almost flat. Vertex twice as broad as long. Hind tibiae with minute spurs.

Holotype female from Coroico, Bolivia, is in the H. Osborn collection at Columbus, Ohio.

Rhamphixius Fowler

Specimens of *championi* Fowler were taken in Chiapas (M. F. 1937) and Quintana Roo (M. F. 622, Dampf), and in Morelos (DeLong & Good) with *Crescenta alata* recorded as host plant.

The male is decidedly smaller than the female and is less highly colored. The illustration in the Biologia (Pl. 9, fig. 10) is similar to most males while most of the females have a much heavier and continuous black stripe around the elytra omitting the costal margin. The genital styles are much reduced in the males.

Male allotype and paratypes, Morelos, 19-22-41 (DeLong & Good). (Fig. 4.)

Nymphocixia Van Duzee

Ten specimens were collected in the Canal Zone, Panama, May, 1927, by H. Osborn. The coloration of these specimens is close to *unipunctata* Van Duzee in that the elytra are hyaline and fuscous with a fuscous V across the transverse veins. The male genitalia coincides with the description of *vanduzeei* Muir. (Fig. 3.)

Nymphocixia vanduzeei var. **floridensis** n. var.

Length 6 mm. Very heavily marked. Elytra mostly fuscous with a milky area extending from the commissural margin across to the stigma where it projects basad forming a somewhat broad V-shaped design. This specimen is larger and darker than *unipunctata* or *vanduzeei vanduzeei*.

Female holotype from Manatee Co., Florida, 1-4-25 (T. H. Hubbell), Osborn collection at Columbus, Ohio.

Pachyntheisa concinna var. **striata** n. var.

(Figs. 6 and 6-A)

Length 4-4.5 mm. The central semitransparent band is not interrupted in the middle of each elytra otherwise the color and marking are identical with *concinna concinna* Fowler. The male styles differ in appearance from those shown by Fowler (Pl. IV, fig. 3c), but this may be due to point of view or differences resulting from treatment with caustic.

Male holotype and female allotype from Tenancingo, Mexico, 10-22-38 (Plummer), paratypes from Mexico, D. F., 11-1-39 (DeLong).

THE HISTORY OF OHIO'S NORTHERNMOST COAL MINE

MYRON T. STURGEON,[1]
Michigan State Normal College,
Ypsilanti, Michigan

The Zeil Pfouts farm, located 2.7 miles northwest of Burton Village in Geauga County, Ohio, is similar in appearance to many of the well kept farms in that vicinity. The Pfouts farm, however, has one distinction that is shared with no other farm in the vicinity for miles around; for between 40 and 60 years ago coal was mined from beneath its acres. This mine was unique in that it was the farthest north of any coal mine ever operated in Ohio. (See Figure 1.) The only other near coal mines, with the exception of an attempt to mine coal 2.15 miles southwest of Welshfield on the east side of the Cuyahoga River, are at least 15 miles farther south along the north-south line and being somewhat farther east or west are actually 25 or 30 miles distant.[2] These mines are in the vicinity of Tallmadge in Summit County, Palmyra in Portage County, and Vienna in Trumbull County.

Concrete evidences of past mining operations on the Pfouts farm have long since been almost completely obliterated. The mine buildings and equipment have been removed, the mine openings filled, and cultivated and pasture fields cover the former mine sites. A green meadow without an apparent trace of a mine opening or mine dump now extends over the site of the main shaft which was located approximately 100 feet west of the Pfouts house. Only small bits

---

[1] This historical account was written at the suggestion and with encouragement of Wilber Stout, State Geologist of Ohio.

The compilation of the historical data was made possible through the help of numerous persons in the Burton and nearby communities. The following persons have furnished information: Charles Burnett, Frank Davis, Lynn Mumford and nephew, Ben Owen, David Owen, Miss Margaret Owen, Zeil Pfouts, R. R. Phillips, Frank Taylor, Mrs. Ina Taylor, F. H. Thwing, and J. M. Zethmayr. J. J. Feicht, of Cleveland, gave a copy of the original lease, and Miss Annie Ashton, of Chardon, copied lease records at the Geauga County Courthouse.

Special acknowledgment is due Miss Bertha Buell and James Glasgow, who read and criticised the manuscript, J. R. Hickman, who aided in the preparation of the photographs, and Miss Anne Frankenberry, who did the typing.

[2] On November 26, 1943, I made an attempt to find the location of the coal prospect near Welshfield in Troy Township, Geauga County. Mr. Frank Taylor kindly directed me to the site, but in the limited time available I was unable to find any positive surface evidence of the attempted mining. The following are published references to this unsuccessful coal mine:

> "In Troy township, the Coal-measure sandstone is separated from the Conglomerate by the coal shales, which are, in places, very thin, and rarely exceed a thickness of six feet. In the southern part of the township, coal has been obtained in small quantities from a seam too thin to be profitably worked. Yet at this point it is probably thicker than in any other part of the county on the east side of the Cuyahoga."—Read, M. C., "Sketch of the Geology of Geauga County," *Report of Progress of the Geological Survey in 1870*, p. 466, Geol. Surv. Ohio (1871) and Read, M. C., "Geology of Geauga County," Geol. Surv. Ohio, Vol. I, Pt. I, p. 521 (1873).
>
> "Evidences of the existence of coal were discovered in 1848–9 on land located in section sixteen, then belonging to Rensselaer Smith, now to Peter Davis. John Brainard, a noted geologist then living in Cleveland, examined the premises, and decided that coal did not exist there in paying quantities. Mr. Smith was not satisfied with this decision, but went to Pennsylvania and procured a practical miner, to come and develop whatever might be found. A few bushels of coal were taken out, which were used by our blacksmiths, but after prospecting less than one hundred feet, the 'mine' came to an abrupt termination. The cavity is now abundantly supplied with excellent water of a very low temperature."—Chapman, William H., "Troy," *Pioneer and General History of Geauga County, Ohio* (Symposium), p. 623, published by the Historical Society of Geauga County (1880).

of dark shale and coal mixed in the soil betray the former existence of a mine there. Approximately 300 feet northeast of the Pfouts house is a broad shallow ravine. Near an old beech tree in this ravine was located the oldest mine opening on the farm from which coal was taken. (See Figure 3.) Some 25 feet southeast was another which was probably a secondary one. These two furnish the best surface evidences of mining operations. There is a low pile of weathered shale largely concealed by blackberry bushes and rubbish. A depression and several

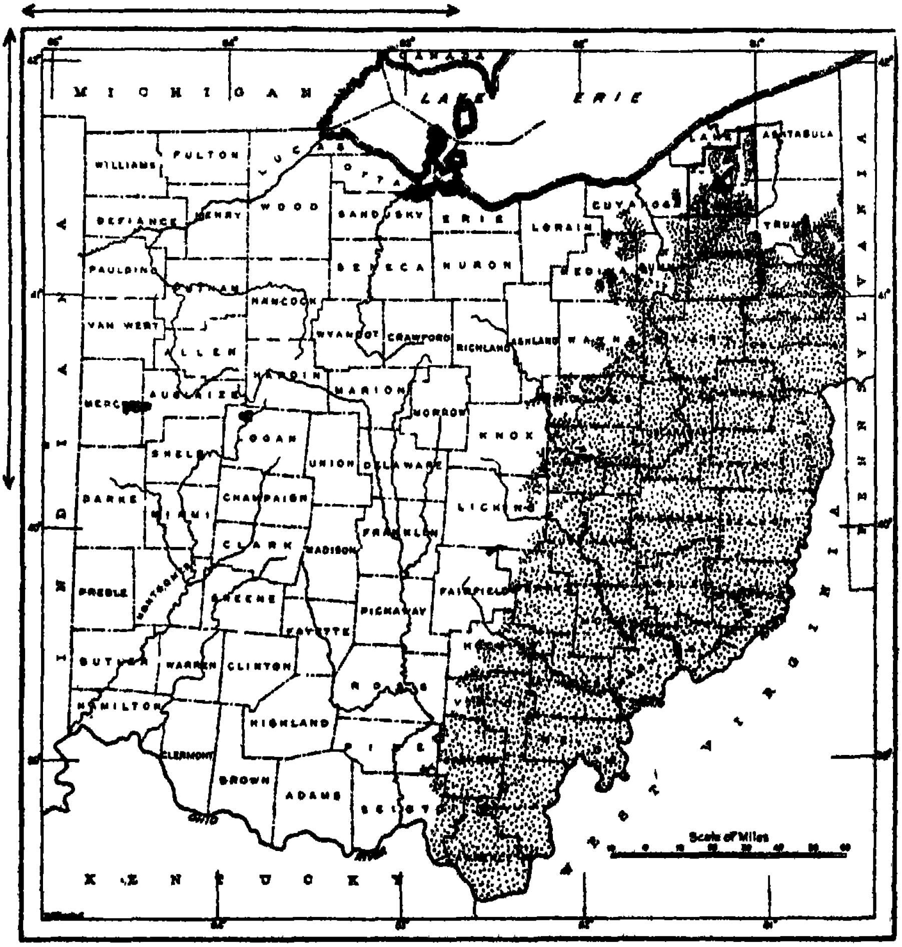


Fig. 1. Map of Ohio showing the location of the coal mine near the Village of Burton in Geauga County and the distribution of the Pennsylvanian and Permian Systems (Coal Measures) by stippling.

cave-ins partly filled with rubbish and field stones mark the entrance and the course of the main slope. A depression is all that is indicative of the location of the secondary slope. Within a radius of 400 feet around the house, Mr. Pfouts showed me seven additional locations of mines, two of which were slopes and five of which were shafts. They were used for ventilation, drainage, and removal of coal. This number does not include numerous prospect pits which were dug from time to time both before and during the operation of the mines. The approximate locations of the ten mine locations are shown in Figure 2. Without Mr. Pfouts' help it would have been impossible to find the locations of most of them; for, as already mentioned, the surface evidences of their sites, consisting of bits of dark shale and coal mixed in the soil, a tiny weathered shale pile, slight depressions, and now and then a fresh cave-in, are meager. When cave-ins occur, they are filled as quickly as possible with whatever debris is at hand. They have occurred along the east-west road near the Pfouts buildings and in the adjacent fields. On one occasion the road gave way over one of the abandoned mine entries with the passage of a truck loaded with brick and cement. On another occasion the ground in a field on the south side of the road caved under one of Mr. Pfouts' horses. With such slight surface indications of mining one could drive past the Pfouts farmstead on the public road for a lifetime and never be aware of the existence of these former mines.

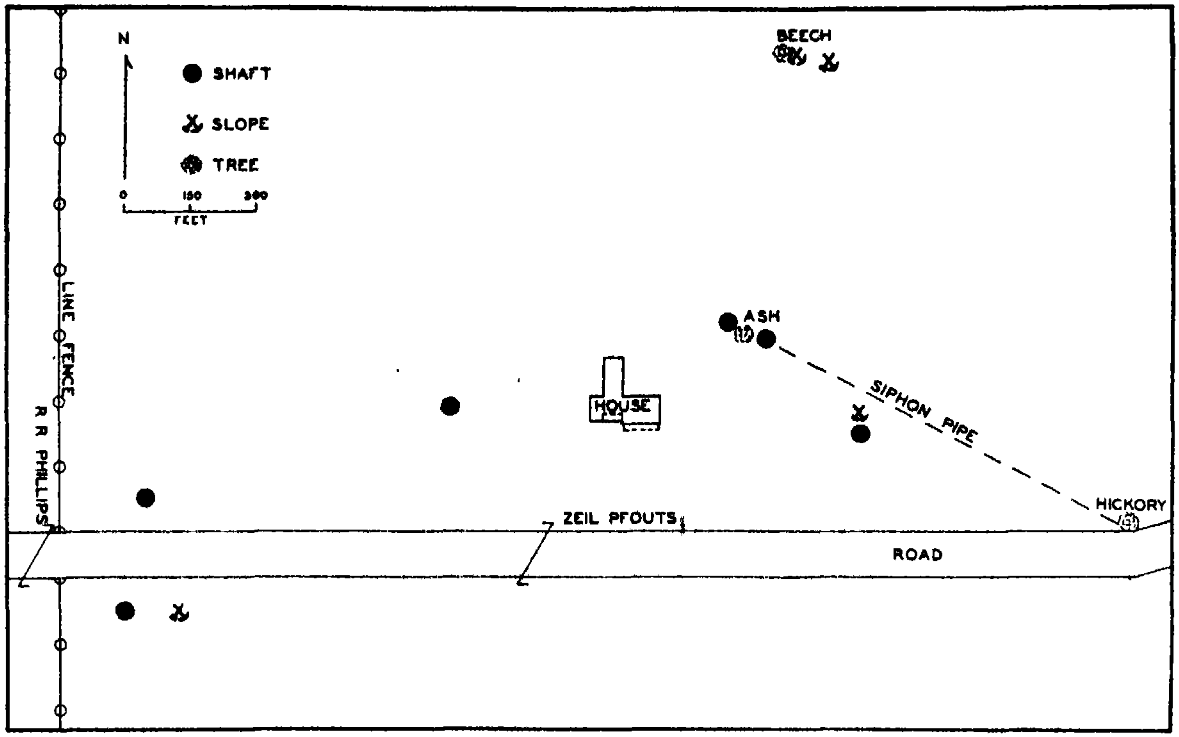


FIG. 2. Map of parts of the Zeil Pfouts and R. R. Phillips farms showing the location of the former mine openings.

Many of the facts concerning these mining operations have been lost. I have been unable to ascertain how and when coal was discovered in the Burton vicinity. There are no good exposures of coal in the immediate vicinity on account of the almost continuous mantle of glacial till. Nevertheless coal was long ago reported at several nearby places. As early as 1871 Newberry wrote as follows:[3]

> In Geauga county the Briar Hill coal reaches as far north as Burton and Newbury, but only in a narrow strip and detached islands, and is there thin and of little or no value.

---

[3] Newberry, J. S., "Sketch of the Structure of the Lower Coal Measures in Northeastern Ohio," *Report of Progress of the Geological Survey in 1870*, p. 27, Geol. Surv. Ohio (1871).

In the same report and in a subsequent one published two years later (1873) Read wrote as follows:[4]

> At Burton, the coal shales and the seam of coal are thicker—the rocks of the Coal-measures reaching a thickness of 125 feet; and if the village is to remain without railroads, further exploration of the coal seam, by shafting or drifting, is advisable, as there are indications of coal in sufficient quantities to be profitably mined for local consumption. There is, however, no probability of a supply sufficient to warrant its shipment elsewhere, or to enable the owners to compete, even in the Burton market, with coal from the main coalfields of the State, in the event of a railroad being built. Near the northeast corner of Newberry township, coal of very good quality, about two feet thick, has been disclosed in sinking a well on Mr. Frank Stone's farm, and at a depth of about ten feet from the surface. Here a thin stratum of shale covers the coal, not thick enough to constitute a safe roof; but to the west and northwest, the surface of the land rises, and over a small area it is possible that a sufficient cover may be found to allow of the coal being taken out. The quantity, however, is not large, and what coal there is must be sought near the summit of the hill

The Frank Stone farm (now R. R. Phillips) lies immediately to the west of the Pfouts farm.

Ford, writing in the *History of Geauga County* published in 1880, makes a brief mention of coal:[5]

> Bituminous coal was found in the hill south of the square, near where George Carlton now lives, by Rev. Dexter Witter and Daniel L. Johnson, esq., but not in paying quantities; and also about three-fourths of a mile north of the "old garden," near the residence of Judge Stone.

No date is given for the discovery by the Rev. Mr. Witter and Mr. Johnson. It is revealed in the above history that the Rev. Mr. Witter first came to Burton in 1821, but did not live there regularly until 1828 and that Mr. Johnson was a boy when his parents moved from New York State to Burton in 1833. Both men were still living when the *History of Geauga County* was written.[6] George Carlton lived in what is now known as Carlton Street on the south edge of Burton. The "old garden" is located at North Burton and is near the Pfouts farm.

Coal is reported to occur on the Lynn Mumford and Frank Davis farms located one mile west and one and three-fourth miles southwest, respectively, of the Pfouts farm.[7] Although coal may once have outcropped on those farms, it is no longer exposed, according to Mr. Mumford and Mr. Davis. Coal is reported by Mr. Mumford at a depth of 43 feet in the drilled well at his milk house. Coal is also reported to have been encountered in other wells drilled in the vicinity, and it is possible that the digging and drilling of water wells played an important part in the discovery of the coal. The wells cited here have been drilled since mining ceased. On the O. Buehner property on the east side of Route 44 and a little less than a mile northwest of the Pfouts farm, two feet of coal are reported at a depth of 42 feet.[8] In the well on the Louis Bukovics property near the west end of Carlton Street in Burton Village, three feet of coal are reported in the interval between a depth of 45 and 60 feet.[9] Only this last autumn (1943) Mr. Burnett reported coal at a depth of 12 feet about one-half mile south of the center at Claridon.

---

[4] Read, M. C., op. cit., p. 466 and pp. 521–22.

[5] Ford, W. J., "Burton," *Pioneer and General History of Geauga County, Ohio*, p. 420, published by the Historical Society of Geauga County (1880).

[6] Idem., pp. 485 and 579.

[7] Burnett, Charles, Oral communication, August or September, 1942.

[8] Idem.

[9] Thwing, F. H., Oral communication, September, 1942.

From the available evidence it appears that the presence of coal in the vicinity of Burton was known at least 15 years and possibly much longer before the mining began.

Active prospecting and first mining of the coal on the Pfouts farm began as early as 1884, and prospecting may have been begun even earlier. On May 27, 1884, Edward Blunt and David John leased the coal mining rights from Howard Pfouts, the father of Zeil Pfouts. This lease was assigned to D. E. Owen on May 2, 1891. The June 26, 1884, isues of the *Burton Independent* in a North Newbury news item had the following:

> The coal shaft has been abandoned on account of high water.

FIG. 8. Beech tree and location (at arrow) of the oldest slope northeast of the Pfouts house.

On September 5 of the same year the *Geauga Leader* carried the following in the North Newbury news column:

> After sinking the fifth shaft, coal has been found in paying quantities. Parties from Youngstown are moving their families and are to mine the coal.

A second lease, not identical in wording but very similar in import, is dated June 12, 1885. In it Edward Blunt and David John subleased the coal mining privileges on the Pfouts farm to Edward (Ned) James and M. Owens. On January 1, 1886, the second lease was assigned by Edward James to D. E. Owens, agent for M. Owens.

A copy of the first lease is appended at the end of this account in Appendix I. All of the participants in the leasing of the rights with the exception of Howard Pfouts were Welsh. They came from the Welsh colony at Mineral Ridge, Ohio, with the depletion of the coal in that district. David E. Owens was the husband of M. (Mary) Owens and the son-in-law of David John.[10] David E. Owen was an accountant, not a miner, but nevertheless it was he to whom the leases were assigned and who directed the mining operations during most of the period of active mining. It seems that David John and Edward Blunt, who had connections with the mining industry in Mineral Ridge, either discovered or learned of the presence of coal on the Pfouts farm and were instrumental in having Mr. Owen assume the leases to coal rights on that property. Although he attempted it, Mr. Owen was never able to lease the coal rights on the George E. Barnes (formerly Frank Stone and now R. R. Phillips) farm, which lies immediately to the west of the Pfouts farm and east of Route 44, although he rented and farmed it and lived there for some time.[11]

The mines were operated under the name of the North Burton Coal Company. The first opening for the commercial removal of coal was the slope by the beech tree northeast of the Pfouts house. Later the main shaft directly west of the Pfouts house was dug, and after a period of mining it too was abandoned. Shortly thereafter other openings were dug along the road west of the Pfouts house and east of the line fence. One of them was a shaft on the north side. A shaft and a slope were located almost directly across the road. The slope, located 40 feet east of the shaft, extended under the road. This is the place where a cave-in occurred under one of Mr. Pfouts' horses a few years ago. The locations of these three mines are only discernible by the bits of dark shale and coal. The slope in the orchard 150 feet due east of the Pfouts house was the last opening from which coal was mined on the farm. Associated with this slope were three lesser shafts. One was directly south of the slope, and two were located northwest near an ash tree. One or more of these shafts may have antedated the slope. They were used for ventilation and for siphoning water from the mine. The only trace of this slope and of these three shafts is an abundance of black shale and coal in the soil. The locations of all of these former mine openings are shown in Figure 2.

Several informants have reported the average thickness of the coal to be 30 to 36 inches and the maximum thickness to be four feet. The coal was apparently deposited in channels or basins and is lenticular in its development. Mineable thicknesses, accordingly, are extremely patchy in distribution. The overburden is thin and probably does not exceed 24 feet in thickness. The following geologic section has been compiled from available sources of information:

5. Glacial till: comprises most of overburden above coal. . . . . . 15′ to 24′
4. Shale: dark, thin . . . .
3. Coal: bituminous with some cannel in lower part and with some scattered marcasite throughout, *Sharon* . . . . 2′ 6″ to 3′ 0″
2. Clay: thin, locally present. . . . .
1. "Rock": sandstone or conglomerate, *Sharon*.

Such a roof of till and shale over the coal made mining operations dangerous and troublesome and required timbering for every foot of the underground workings. That greatly increased the labor and costs in mining the coal. Rotting timbers in the old mine openings have permitted the cave-ins from time to time.

---

[10] Later in life David E. Owen dropped the "s" from his last name. Herein following the name Owen will be used.

[11] Mr. Owen did not bring his family from Mineral Ridge until 1886, when he with his wife and children moved into the house on the northeastern corner of the crossroad just southeast of Alderman Pond. This house is now in ruins. Later the Owen family moved to the George E. Barnes farm and finally to North Newbury which is at the crossroad west of the Barnes and Pfouts farms. In 1900 Mr. Owen and his family moved to Burton Village.

Water also is reported to have been troublesome. From some openings it was removed by a water cage and from at least one other by a siphon. The siphon pipe extended from a shaft near the ash tree northeast of the house to the bitternut hickory tree at the bend of the road southeast of the house. (See Figure 2.) It was set in operation by means of a pitcher pump. The removal of water from the mine dried up the shallow dug well at the Pfouts buildings.

From the slope by the beech tree the coal was brought out in mine cars hauled by a donkey or a little mule. From the other openings the cars were lifted or pulled by a jenny wheel operated by one or more horses. The jenny wheel and shaft opening were covered by a shed, the sides of which could be removed in warm weather.

The coal contains much sulphur and ash and is only of fair quality. Nevertheless it is reported to have burned well in spite of much ash and many clinkers. The coal is both bituminous and cannel and was used locally for domestic purposes, in the maple sugar camps, and in steam engines. It was sold at the following prices:

Lump coal	$2.50 per ton
Nut coal	2.00 per ton
Slack (used in maple sugar camps)	1.00 per ton

The coal here is the Sharon member or Number 1 coal. It is the oldest coal in the Coal Measures (Pennsylvanian System) in Ohio. This is the same seam that once was extensively mined in northeastern Ohio in the vicinity of Massillon, Mineral Ridge, Youngstown and other communities where it was known as the "Block Coal."

The output of coal from all mining operations on the Pfouts farm was small in spite of the fact that the mines were in operation for almost 20 years. Mr. Owen's record books have been lost or destroyed, and hence it is impossible to determine the total tonnage of coal mined. The mines were idle during the summer months and only one or two miners worked at any time. The equipment and facilities were crude and small in comparison with modern mining equipment In addition to digging coal, Mr. Owen and his employees did all the necessary blacksmith and carpenter work. They made most of their equipment and tools.

The length of time that any of the mine openings was in operation must have been short. As stated previously, the slope at the beech tree was probably dug in 1884, yet Zeil Pfouts states that this slope and the main shaft west of the house were both already abandoned by about 1890.[12] The last slope in the orchard east of the house was in operation in 1901 and may have continued in operation for one or two years longer.

Not many facts are known about the men who worked in the mines. David John, who was a blacksmith, and Edward Blunt, who is reported to have sold insurance, seem to have been interested in the mining principally as promoters. They probably performed little or no manual labor in prospecting and mining. David E. Owen, however, did all types of work connected with the mine as well as managing it. Edward (Ned) James is reported to have been the first miner employed by Mr. Owen and probably did much of the actual work in digging and working the first slope at the beech tree. Later William Bowen, a miner from Mineral Ridge, and Isaac Owen, a half brother of David E. Owen, were employed. They did not like the rural atmosphere of the North Burton neighborhood and remained only a short time. Still later Will Jones, Mr. Owen's nephew, came from Mineral Ridge and worked in the mine for a few months. Mr. Owen's older sons also helped with the mining. Finally there was Christ Maggs, from Girard, Ohio, who helped to dig the slope east of the Pfouts house and who operated it alone until mining was abandoned on the farm.

---

[12] He relates that he was born in 1883 and that he was six or seven years old when the main shaft was filled. An event that happened during the filling of the shaft firmly impressed it on his mind. A team of horses was engaged in hauling debris to fill the shaft. The team was driven too near the open shaft, and the edge caved in and threw one horse over the brink. The weight of the unfortunate horse hanging over the edge and attached to its team-mate by the harness threatened to drag the second horse into the shaft. Quick action in cutting the harness saved the second animal. The other dropped into the shaft, which was partly filled with water, and was drowned.

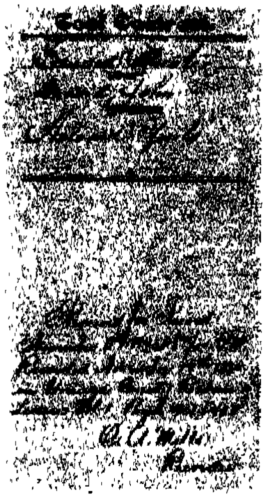
Although the mining there ended about 40 years ago, interest in the coal has been revived from time to time. The Owen family held the lease to the coal rights on the Pfouts farm for a number of years and made semi-annual payments until August 2, 1922. In 1933, J. J. Feicht of Cleveland leased the Pfouts and Phillips farms and attempted unsuccessfully to strip the coal. Since then James Sober of Salem, Ohio, test drilled the Pfouts and other nearby farms but attempted no mining.

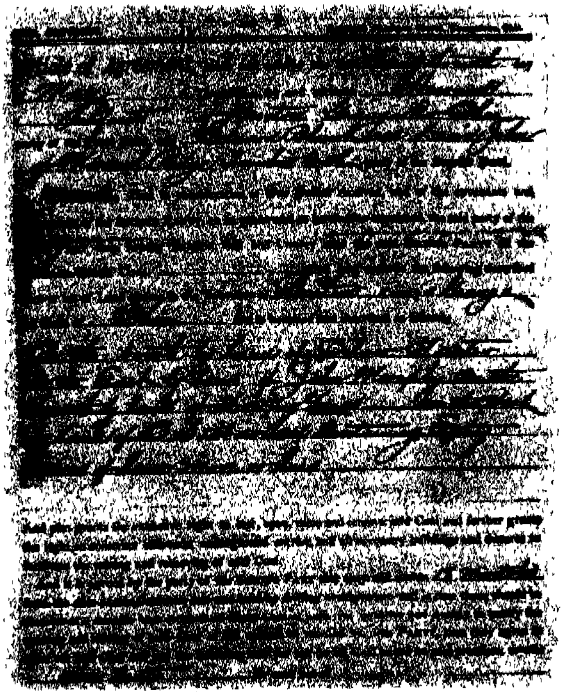
REFERENCES

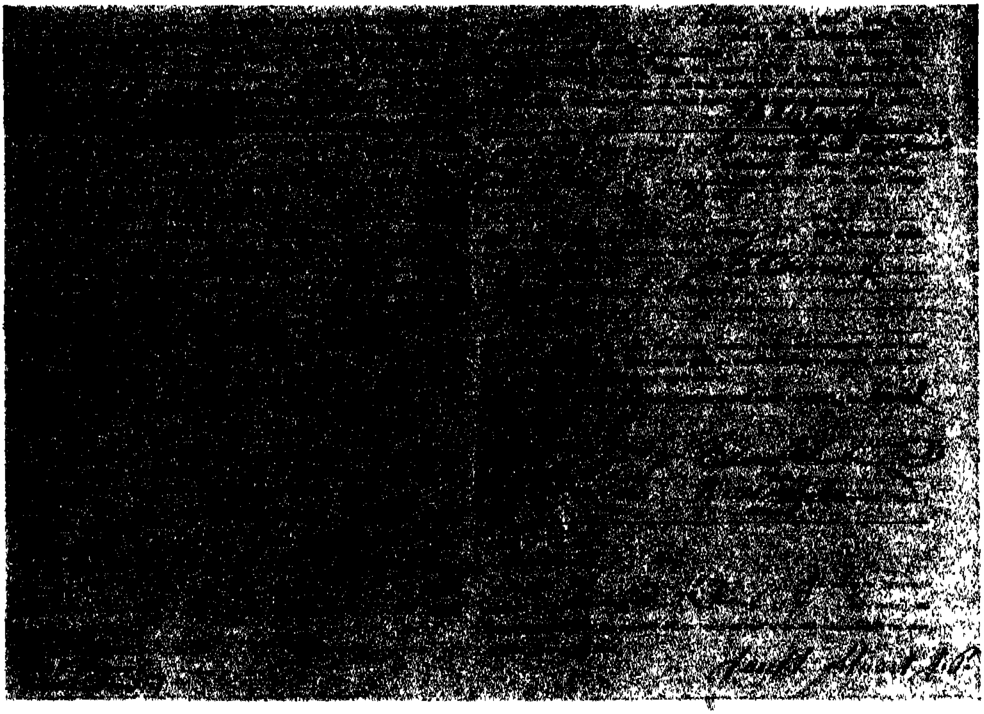
1. *Report of Progress of the Geological Survey in 1870*, Geol. Surv. Ohio, Columbus, Ohio, 1871.
2. *Report of the Geological Survey of Ohio, Geology*, Vol. I, Part I, Geol. Surv. Ohio, Columbus, Ohio, 1873.
3. *Pioneer and General History of Geauga County*, Hist. Soc. Geauga County, Burton, Ohio, 1880.
4. *Atlas of Geauga County, Ohio*, H. B. Stranahan & Co., Cleveland, Ohio, 1900.
5. *Burton Independent*, Burton, Ohio, June 26, 1884.
6. *Geauga Leader*, Burton, Ohio, September 5, 1884; October 16, 1907; January 1, 1913; February 21, 1922.

APPENDIX I

Copy of coal contract signed by Howard Pfouts, Edward Blunt, and David John on May 27, 1884.





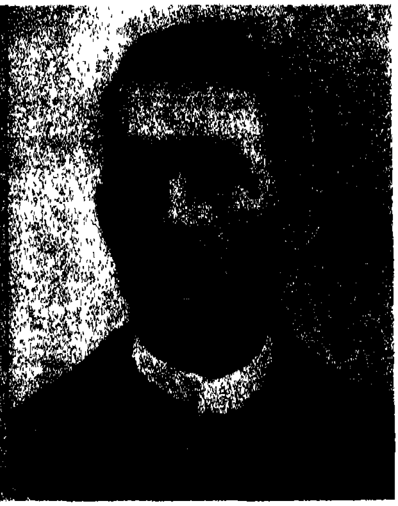


APPENDIX II

BIOGRAPHIC SKETCHES

A. DAVID ELSWORTH OWEN
1847-1922

David Elsworth Owen was born in Wales on July 6, 1847. His parents emigrated to the United States the following year and settled at Mineral Ridge in Trumbull County, Ohio He was reared in that town and by diligent effort was able to attend Iron City Commercial College in Pittsburgh. After his graduation he became an accountant and followed that profession during much of his life. About 1880 he became interested in the coal deposit near Burton, Ohio, through his father-in-law and others and eventually secured the mining rights and operated mines at North Burton. Although mining began in 1884, Mr. Owen and his family did not move from Mineral Ridge to North Burton until 1886. From that year until 1900 he engaged in mining, farming and storekeeping. In 1900 Mr. Owen moved his family to Burton Village where he pursued varied activities. He was postmaster from 1905 to 1913. A short time after his retirement from that office his health failed. His death occurred on February 8, 1922. He was the father of ten children, four sons and two daughters of whom survived him. He was a member of the Disciple Church and the Masonic Lodge.



B. HOWARD PFOUTS
1857-1907

Howard Pfouts was born in Wayne County, Ohio, on October 27, 1857. When he was seven years old his parents moved to Beach City, Ohio, where he resided until shortly after his marriage to Miss Clara Walter in 1881 The same year he moved to the farm at North Burton which is now the home of his son, Zeil. He was a farmer throughout his life and lived on this farm until his death in October, 1907. His relatively early death was caused by an accidental fall from a tree. His farm was the site of Ohio's northernmost coal mine, and all of the mining operations were carried on during his lifetime. He was the father of four children, all of whom survived him. He belonged to the Grange and to the Methodist Church and at the time of his death was a member of the Board of Education.

OVIPOSITOR STUDIES OF THE LEAFHOPPER GENUS ERYTHRONEURA

(HOMOPTERA: CICADELLIDAE)

MARY AUTEN TRAUTMAN,
Franz Theodore Stone Laboratory,
The Ohio State University,
Put-in-Bay, Ohio

Since determination of species in *Erythroneura* is based mainly on wing venation, color pattern, and inner male genitalia, it was believed that a study of ovipositors might lead to discovery of characters that would be of use in identification of females. Such a study was begun in 1937. Most of the work was done at the Stone Laboratory, the remainder at Ashland College I wish to express my appreciation to Dr. D. M. DeLong for his early assistance in the work; to Dr. F. H. Frison for loan of material from the Illinois Natural History collections; to Mrs. Dorothy J. Knull for identification of specimens, for use of material, and advice; and to Dr. T. H. Langlois, the present Director of the Stone Laboratory, for use of facilities. I also wish to express my appreciation to Ashland College for giving me the opportunity to continue these studies while teaching there.

METHOD OF PREPARATION OF OVIPOSITORS

The tip of the abdomen of a mounted specimen was removed by the use of minuten nadeln This was soaked in 70% alcohol, using artists' porcelain paint dishes for this purpose. One hour was sufficient for softening, although a longer period of time was not detrimental. The ovipositor sheath and valvulae were then dissected under binoculars with minuten nadeln and dehydrated on the slide by first removing as much of the alcohol as possible with a small piece of cheese cloth. The ovipositor was then shifted to a dry place on the slide after which a drop of dioxane was added and immediately removed with the aid of cheese cloth. Next a drop of thin balsam was placed on the genitalia and a cover glass put in place. The following step was the most delicate of the whole process. The cover slip was gently but firmly rotated in such a manner as to slip the four ovipositor blades apart. This was accomplished with the aid of a heavy, No 7, insect pin. The position of the heavy-toothed blade was marked with india ink and the slide, after drying for several days, was ready for study. No staining was necessary since the amber color of the chitin gave satisfactory outline of the ovipositor.

INTRA-SPECIFIC COMPARISONS OF OVIPOSITORS

Erythroneura basilaris (Say), *E. compta* McA. and its variety *E. compta* var. *rufomaculata* McA., and *E. tricincta* Fitch were chosen for studies of large series to determine whether there are variations within the species. These were selected because they form well marked series, and individuals of each species were collected from the same host on the same day, indicating that they should belong to identical species. *E. basilaris* (Say) was collected on July 5, 1938, from red elm (*Ulmus fulva*) on North Bass Island, Ohio. *E. compta* McA. on July 22, 1937, from cultivated grapes (*Vitis* sp. and *Muscadinia* sp.) on North Bass Island, Ohio, and *E. tricincta* Fitch on July 19, 1938, from cultivated grapes on Middle Bass Island, Ohio.

Ovipositor slides of 53 specimens of *E. basilaris* (Say), 95 specimens of *E. compta* McA. and 89 of *E. tricincta* Fitch were prepared. After making camera

TABLE I

SHOWING CONFORMITY OF OVIPOSITOR FORM IN SPECIES OF FIVE GROUPS OF *Erythroneura.*

COMES GROUP

	TYPICAL	ATYPICAL
aclys McA.	3	
nudata McA	2	
beameri Rob.	9	
bistrata	9	
cancellata McA.	3	
coloradensis (Gill.).	11	
comes (Say)	31	5
compta McA.	15	
corni Rob.	5	
delicata McA.	9	1
elegans McA.	6	
infuscata (Gill.).	4	
kanwakae Rob.	9	2
ontari Rob.	10	
pontifex McA.	7	
rubra (Gill.).	5	
tricincta Fitch.	9	1
vitifex Fitch.	4	4
vitis (Harris).	14	4
vitis var. *corona* McA.	13	

MACULATA GROUP

	TYPICAL	ATYPICAL
abjecta Beamer.	2	
accola McA.	4	
adunca Beamer.	3	
affinis Fitch.	14	
arta Beamer.	10	
basilaris (Say).	15	
bella McA.	6	
bigemina McA	2	1
brevipes Beamer.	4	
calamitosa Beamer.	1	1, 1, 1
campora Rob.	7	6, 4, 1
carmini Beamer.	3	
certa Beamer.	12	4, 2, 2, 1
concisa Beamer.	2	
confirmata McA.	4	
consueta Beamer	3	
contracta Beamer.	2	1
curvata Beamer.	5	
delongi Knull and Auten.	3	
dira Beamer.	3	
parallela McA	5	
era McA.	6	
gemina McA	3	
hartii (Gill.).	4	
hymae Rob.	2	1
illinoiensis (Gill.).	6	1
ingrata Beamer.	3	
kansana Baker	4	3, 1, 1
knighti Beamer	6	4, 1
lawsoni Rob.	11	1, 1
lata Beamer.	2	
maculata (Gill.).	12	2
minor Beamer.	3	
morgani (DeL.).	12	
omani Beamer.	4	
pallida Knull and Auten.	2	
pyra McA.	8	
rotunda Beamer.	2	
torella Rob.	3	
trivittata Rob.	3	
ungulata Beamer.	2	
usitata Beamer.	5	

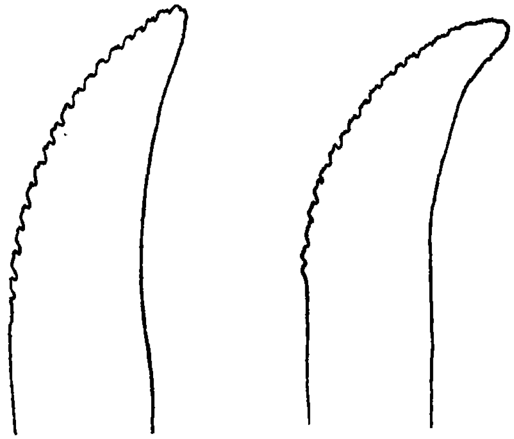
OBLIQUA GROUP

	TYPICAL	ATYPICAL
albescens Beamer.	6	
angularis Beamer.	9	1
apacha Baker	4	
atrimucronata Beamer.	2	
bitincta McA.	2	
brundusa Rob.	10	
clavata DeL.	4	3
crevecoeuri (Gill.).	2	
cruciformis Beamer.	4	
diffisa Beamer.	8	4
electa McA.	2	1
fulvocephala Rob.	4	4, 2, 2
funesta Beamer.	6	
gleditsia Beamer.	3	
hamata Beamer.	3	
kanza Rob.	7	
lawsoniana Beamer.	3	
plena Beamer.	7	
rubens Beamer.	2	
rubroscuta (Gill.).	3	
tenuispica Beamer.	5	1
tridens Beamer.	2	
stolata McA	2	

VULNERATA GROUP

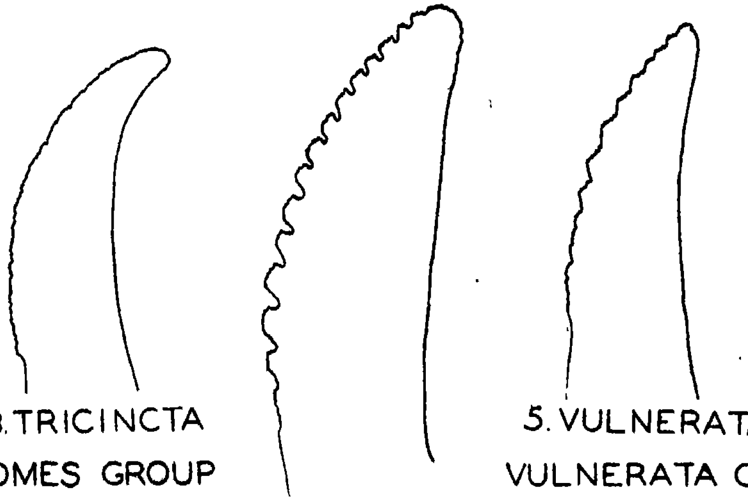
	TYPICAL	ATYPICAL
nigerrima McA.	7	
nigra (Gill.).	3	
vulnerata Fitch.	16	
var. *fulmina* McA.	2	

lucida drawings of a sample of each species the other slides were compared with these drawings by placing the slide on the stage of the microscope and following the outline of the ovipositor by means of the camera lucida. This method of checking eliminated making drawings of all 237 slides.



1.BASILARIS
MACULATA GROUP

2.COMPTA
COMES GROUP



3.TRICINCTA
COMES GROUP

4.BRUNDUSA
OBLIQUA GROUP

5.VULNERATA
VULNERATA GROUP

Figs. 1-5. Projection drawings of the coarse-toothed median valvulae of the ovipositors of five species of *Erythroneura.*

The coarser-toothed median valvula was used for this study although the lateral valvulae and the finer-toothed median valvula may possess interesting characters. The median valvula was found to be different in each species studied. The general shape of the blade, length of toothed area, and slant and depth of teeth are apparently specific, although minor variations in number of teeth are present.

E. basilaris (Say) in figure 1 shows heavy dentition, general arrangement of the teeth in two subdenticles, and an angular rather than a curved tip, resulting in the ovipositor having an almost straight dorsal edge. All 53 specimens studied showed these characteristics.

E. compta McA. in figure 2 shows that the teeth are of an irregular low type and the tip of the blade is broad and toothed both dorsally and ventrally. The tip is greatly curved, resulting in a concave dorsal margin. All 95 specimens of *E. compta* McA. and its variety *rufomaculata* McA. conformed to this general pattern.

E. tricincta Fitch in figure 3 shows that the teeth are very fine and merely dent the edge of the blade, a constant character. The tip is curved and more pointed than in either *basilaris* or *compta*.

After making studies of the three large series it seemed reasonable to include two smaller series representing the obliqua and vulnerata groups. Ten specimens of *E. brundusa* Rob., a well marked species, were used and all conform to the general pattern illustrated in figure 4. Figure 4 shows coarse teeth, somewhat as in *E. basilaris* (Say) although deeper and not divided into two subdenticles. The dorsal margin is slightly sinuous. Sixteen specimens of *E vulnerata* Fitch showed the general pattern illustrated in figure 5. In this figure the toothed margin is somewhat of a staircase type, slightly flattened, and with the subdenticles on the riser.

In recapitulation, the characters shown by these drawings, namely, the coarse teeth of two subdenticles in the maculata group, the distinctive curved tip and fine, irregular teeth in the comes group, the very coarse teeth and sinuous dorsal margin in the oblique group, and the staircase angle of the teeth together with the pointed tip extending slightly ventrad in the vulnerata group, are sufficiently definite to be used with color pattern and wing venation to place individuals in their proper group.

INTER-SPECIFIC COMPARISONS OF OVIPOSITORS

The ovipositors of other species of *Erythroneura*, previously identified on the basis of wing venation, color pattern, and association with males, were studied. The results are given in Table I. Number of specimens studied are indicated by the numbers in the columns under the headings "Typical" and "Atypical." A specimen was considered typical if its combination of characters agreed with the characters of the majority of the specimens referred to as that species. Atypical specimens were those which varied from this combination of characters. These variants probably belong to other species and are the result of inability to identify the females with only the aid of wing venation, color pattern, and association of males. As many as four types of variants (species?) were recorded under a species.

From the evidence presented I conclude that the coarser-toothed median valvula of the ovipositor is of sufficient constancy within a species to be of use in identification.

In this paper no attempt was made (1) to make a key for species identification, (2) to describe the detailed characteristics for any species, (3) to describe the variations present within a species, (4) or to describe the variations occurring within a group. That considerable specific differences occur within groups is demonstrated in the compta group, figures 2 and 3, where differences in size and shape of teeth between *compta* and *tricincta* are very evident, yet their group relationship is plainly indicated by marked similarity in the general shape of the median valvula. Obviously the next step is to make keys for species identification, using ovipositor characters together with wing venation and color pattern as is done with the males.

DESCRIPTIONS OF SIX TYPHLOCYBAS FROM THE UNITED STATES

(HOMOPTERA: CICADELLIDAE)

DOROTHY J. KNULL,
Ohio Biological Survey,
The Ohio State University,
Columbus 10, Ohio

Five of these Typhlocybas belong to the Rosae Group and the sixth to the Danae Group. Unless other deposition is indicated all material is in the collection of the writer.

Typhlocyba cassiopeia n. sp.

Robust, cream colored, eyes pale, vertex and pronotum yellow-tinged, scutellum white, elytra yellow semihyaline, apical cells faintly clouded, creamy white below. This species is near *T. pomaria* McAtee.

Female genital segment three times as long as preceding, only slightly produced, rounded, ovipositor black-tipped, exceeding pygofer. A pair of black spots half way from base separated by width of ovipositor. Inner male genitalia: In ventral view aedeagus shaft narrowed on outer third, lateral processes almost parallel and in front of shaft, diverging gradually, sinuate on outer half, a third longer than shaft; in lateral view, aedeagus small, curved dorsad a third of distance from base at right angles to it, shaft slender, inconspicuous, lying dorsad between a pair of heavy lateral processes which exceed it by a third; ninth segment with ventral angle subrectangular, slightly pigmented, dorsal margin rounded obtusely; outer claspers rather stout, narrowed after middle to spoon-shaped pigmented apices which diverge a little; inner claspers slender, outcurved, aciculate.

Length: Male and female, 3½ mm.

Male holotype, allotype and paratypes, Colorado Springs, Colo., July 19, 1938, D. J. & J. N. Knull, collectors; paratypes, Vineland Station, Ontario, W. L. Putman, collector, taken on a series of dates between July 27 and August 2, from 1938 to 1941, reared from *Prunus serotina* Ehrh. Paratypes in the Canadian National Collection, No. 5503.

Typhlocyba putmani n. sp.

Yellowish white, more yellow on vertex, golden yellow below; eyes tan; elytra shining subhyaline. Related to *T. pomaria* McAtee, but spine of pygofer not as prominently falcate.

Last ventral segment in female with margin faintly sinuate, slightly emarginate over ovipositor which is black-tipped and exceeds pygofer by its width. Male genitalia: In lateral view pygofer spine protruding slightly from ventral posterior corner, sharp, heavy, dark, lying along posterior margin of pygofer, aedeagus with processes evenly curved and tapered from base to pointed apices which are directed latero-caudad, shaft hidden by a process to apex which protrudes ventrally at about one-third length of process; from ventral view, aedeagus three-pronged, shaft tapering to a fine point, a pair of lateral processes, each about a fourth longer than shaft, separated from shaft at base by about twice its width, extends roughly parallel to its entire length, becomes sinuate and turns latero-caudad at apex. Styles of usual type.

Length: Male, 4 mm.; female, 4½ mm.

Male holotype, allotype and paratypes, Vineland Station, Ontario, July 16, 1940, W. L. Putman, collector, from *Cornus* spp.; other paratypes with same data collected July 12 and 13, 1940. Types in Canadian National Collection, No. 5504; paratypes retained by author.

Named for W. L. Putman, who has done interesting work in rearing leafhoppers.

Typhlocyba oneka n. sp.

Slender, pale yellowish white, elytra semihyaline, below cream-colored, eyes pale.

Female, last ventral segment large, concave, roundly, almost semicircularly produced on outer half, no indentation, a pair of dark points one-third distance from apex separated by more than width of ovipositor, sometimes indistinct; ovipositor exceeding pygofer by more than its width. Male genitalia: Ninth segment with posterior angle produced dorsad forming less than a right angle, margin rounded, ventral angle a little sinuate, darkened at tip, sharp, almost a right angle. Outer claspers long and slender, tapered gradually, constricted on outer third which is spatulate and curved laterad, pigmented toward apex; inner clasper hairy at base, outcurved, slender, somewhat aciculate. Aedeagus from lateral view slender, bifid at apical fifth, curved at a right angle with base about one-fourth distance from base; a pair of very delicate slender processes arises just ventrad to base, extends two-thirds length of shaft, the parts diverging slightly toward apices.

Length: Male and female, 3½ mm.

Male holotype, allotype and paratypes, Cranberry Lake, N. Y., July 15, 1920, from *Corylus*, Osborn & Drake, collectors. Types in the Herbert Osborn Collection at The Ohio State University.

Typhlocyba shawneeana n. sp.

Slender, creamy white with translucent elytra and inner male genitalia remarkably different from any known species.

Male genitalia: Ninth segment almost square on outer margin, ventral corner pigmented; outer plates of moderate length, tapering gently to diverging apices which are swollen knob-like and pigmented; inner claspers rather heavy, enlarged blade-like before aciculate, divergent apices; aedeagus in lateral view complex, composed of a pair of heavy ventral processes arising, swollen at base and curving gently to apex; and a heavy shaft, not quite as long as processes, bifid at apex and with a pair of lateral arms projecting laterad before point of separation of apical arms, exceeding them in length, apical arms divergent; in ventral view shaft is very broad.

Length: Male, 3½ mm.

Male holotype and paratypes, Shawnee Forest, Scioto Co., Ohio, June 9, 1943; paratypes, Monroe Co., Ohio, July 6, 1943; and paratype, Hocking Co., Ohio, September 19, 1943; all collected by D. J. & J. N. Knull.

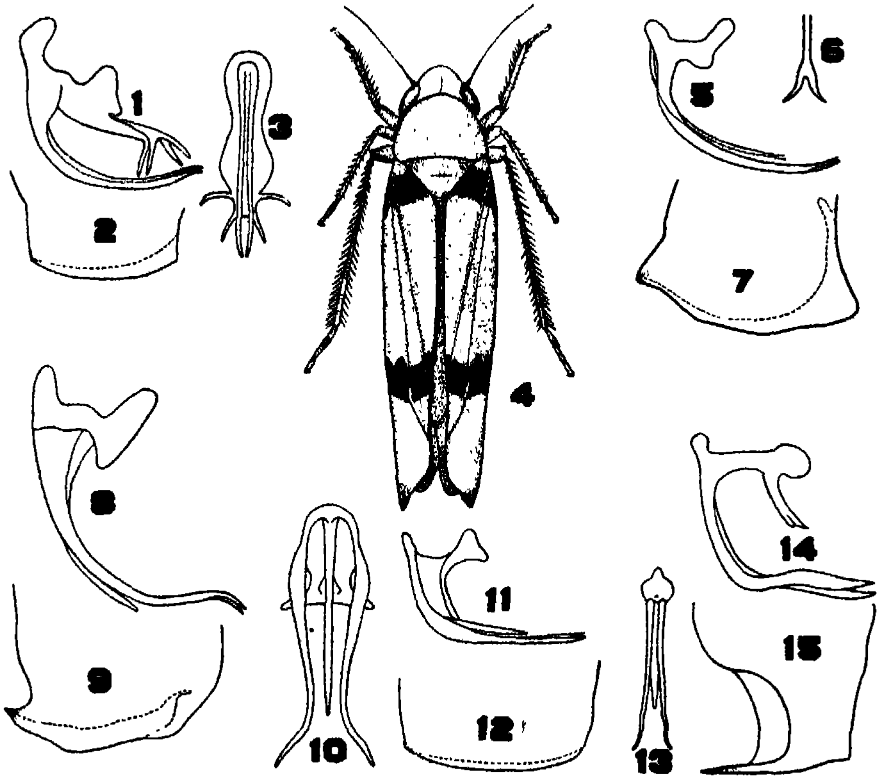
Typhlocyba hockingensis n. sp.

Small, shining golden yellow above and below, gray eyes, elytra semihyaline, apical cells faintly smoky. Distinguished from all but *T. pomaria* McAtee by the falcate process from posterior border of size of ninth segment which is heavily chitinized, pigmented; distinguished from *T. pomaria* McAtee by heavier lateral processes of aedeagus.

Female, last ventral segment long, produced on median third, ovipositor exceeding pygofer by more than its width. Male, spine of pygofer pigmented, strongly protruding from ventral corner; aedeagus in lateral view with weak, short shaft, near apex of connective which is about as long as shaft between it and heavy pair of ventral processes which is three times as long as shaft, extends straight down on upper half, then curved abruptly dorsad at a little more than a right angle and is enlarged on apical half, then narrowed gradually to pointed apex; from ventral view shaft is not visible, processes are about parallel entire length, sinuate, apices turned in.

Length: Male and female, 3¼ mm.

Male holotype, Hocking Co., Ohio, June 19, 1943; allotype, May 29, 1938; paratypes, May 29, 1938, to September 16, 1943; also paratypes as follows: Shawnee Forest, Scioto Co., Ohio, June 9, 1943; Great Smoky Mt. Nat. Park, Tenn., June 21, 1942; all collected by D. J. & J. N. Knull; and Indian Gap, Smoky Mts., Tenn., September 3, 1939, Mary Auten, collector. Paratypes in Collection of The Ohio State University and in the Canadian National Collection, No. 5505.



EXPLANATION OF PLATE

1. Lateral view of aedeagus of *T. shawneeana* n. sp.
2. Lateral view of hind margin of ninth segment, *T. shawneeana* n. sp.
3. Ventral view of aedeagus, *T. shawneeana* n. sp.
4. Dorsal aspect of *T. hinei* n. sp.
5. Lateral view of aedeagus of *T. oneka* n. sp.
6. Ventral view of apex of aedeagus shaft, *T. oneka* n. sp.
7. Lateral view of hind margin of ninth segment, *T. oneka* n. sp.
8. Lateral view of aedeagus, *T. putmani* n. sp.
9. Lateral view of hind margin of ninth segment, *T. putmani* n. sp.
10. Ventral view of aedeagus, *T. putmani* n. sp.
11. Lateral view of aedeagus, *T. cassiopeia* n. sp.
12. Lateral view of margin of ninth segment, *T. cassiopeia* n. sp.
13. Ventral view of aedeagus, *T. cassiopeia* n. sp.
14. Lateral view of aedeagus, *T. hockingensis* n. sp.
15. Lateral view of margin of ninth segment, *T. hockingensis* n. sp.

Typhlocyba hinei n. sp.

Near *T. bifasciata* Boh., an European species, but with scutellum pale. Chalky white with dark brown eyes and two transverse bands on the elytra, the anterior extending from sides of scutellum across clavus, extending slightly caudad on corium, reaching costal margin but leaving pale anterior humeral part; the posterior band before crossveins, extending from apex of clavus curving a little cephalad toward costal margin, and narrowed. The elytra seem opaque but for costal area between bands and apical cells which are fumose semihyaline, veins white. Below white. This species belongs to the Danae Group.

Length: Female, 4 mm.

This beautiful insect is named for the late J. S. Hine, who collected a specimen. It occurs on white oak along with *T. tunicarubra* Gill.

Described from a series of females. Holotype and paratypes, Delaware Co., Ohio, July 8, 1942; paratypes July 1 and 15, 1943; all collected by D. J. & J. N. Knull; and a paratype, Wauseon, Ohio, July 8, 1896, J. S. Hine, collector. The Hine paratype is in the Herbert Osborn Collection at The Ohio State University.

NOMENCLATORIAL NOTES ON CICADELLIDAE

DWIGHT M. DELONG,
Department of Zoology and Entomology, Ohio State University,
Columbus, Ohio

The following new names are proposed for one genus and four species with names already preoccupied:

Genus

Calanana n. n. for *Calana* DeLong (Ohio Jour. Sci., 36: 218, 1936), not *Calana* Gray, Proc. Zool. Soc. London, 15: 148, 1847 (Mollusca).

Species

Nesosteles neglecta var. *pallidens* n. n. for *Nesosteles neglecta* var. *pallida* (DeLong & Davidson) (Ohio Jour. Sc. 33:55, 1933), not *Nesosteles pallidus* (Osborn) (Anns. Ent. Soc. Amer. 19: 352, 1926).

Dikraneura lentana n. n. for *D. lenta* DeLong (Ohio Jour. Sci. 38: 218, 1938), not *D. lenta* McAtee, Jour. N. Y. Ent. Soc. 34: 160, 1926.

Empoasca davidsoni n. n. for *Empoasca mucronata* Davidson & DeLong (Ohio Jour. Sci. 38:90, 1938), not *E. mucronata* Ribaut, Bull. Soc. Hist. Nat. Toulouse 65: 150, 161, 1933.

Typhlocyba pruniella n. n. for *Typhlocyba pruni* DeLong & Davidson (Ohio Jour. Sci. 34: 16, 1934), not *T. pruni* Edwards, Entomologists Monthly Magazine 25:158, 1888.

A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART—AVES IX.

COLIIFORMES—PART 1[1]

FRED H. GLENNY[2]
1148 Linden Avenue, Akron 10, Ohio

In several recent studies on birds, the writer has been able to present the significant basic ordinal and important family arrangement-patterns of the main arteries in the neck and thoracic regions. The present paper deals with the arrangement of these arteries in the Coliiformes.

It is significant that, although only three species of Colies are represented in this study, Sclater (1924) recognizes but one genus and six species for the order. The Colies are, therefore, an extremely small group of birds which are found exclusively in Africa.

The taxonomic position of this order of birds has been a subject of much interest. At one time they were placed among the passerine Fringillidae, and later were grouped in the older order Coraciiformes. Wetmore (1940), however, gives them ordinal rank, which, based upon several anatomical evidences, is entirely justifiable.

The information thus far presented in this and previous papers may subsequently afford some clue to possible avian phyletic and genetic relationships, and may later come to be used, in part, as an aid in taxonomic treatises.

MATERIALS[3]

Single specimens of the Speckled Mousebird *Colius striatus* Gmelin (No 227154), the Red-faced Mousebird *Colius indicus* Latham (No. 290394), and the Blue-naped Mousebird *Colius macrourus* (Linné) (No. 290606) were dissected and diagrams of the main cervical and thoracic arteries prepared.

The materials for this study were from the collection of alcoholic specimens of the United States National Museum.

OBSERVATIONS

The arrangement-pattern of the arteries of the neck and thorax is the same for each of the three species of Colies represented in this study.

The innominate arteries (2) arise from the aortic root (1) and pass anteriorly and diagonally toward the base of the neck where they divide to form the common carotid artery and the subclavian artery. The latter gives rise to the coracoid major artery (15), which arises from the ventral face of the subclavian artery between the common carotid and axillary arteries, the intercostal artery (14), which arises from the posterior face of the subclavian just behind the coracoid major, the axillary artery (12), which arises from the anterior face of the subclavian between the common carotid and the anterior pectoral arteries, and finally the two pectoral arteries (13) in order. The coracoid minor artery (11) arises from the axillary artery. The subclavian arteries and branches present a bilaterally symmetrical arrangement.

The common carotid derivatives are not bilaterally symmetrical in their arrangement and must, therefore, be treated separately.

---

[1] Contribution from the Department of Zoology, University of Toronto, Toronto, Ontario, Canada.

[2] Formerly Assistant, Department of Zoology, Univ. of Toronto. Now on Active Service with the Army of the United States.

[3] Numbers after the species are the U. S. National Museum catalogue numbers of specimens used for this study.

The right common carotid (10) gives rise to the right ductus shawi (16) which sends off branches to the trachea (19), syrinx (18), bronchi, and oesophagus; the superficial cervical artery (29), which sends off a scapular artery (24) and other branches to the cervical lymph glands and musculature; a vertebral artery (27); and a secondary or accessory ascending-oesophageal artery (26) from the base of which a short basi-oesophageal artery (28) frequently springs.

The left common carotid artery sends off a tracheo-oesophageal artery (17) from which springs the left ductus shawi (16) which sends off branches to the same organs and other structures as does the right vessel; the cervico-vertebral artery (21) divides into the vertebral (22) and superficial cervical (23) arteries (the latter sends off a scapular artery (24) to the left shoulder region); and the internal carotid (trunk) artery (25) which enters the hypapophysial canal and passes anteriorly to the head where it sends off branches to the left and right sides of the head. Each of these vessels then divides into the complimentary internal and external carotid branches (Glenny, 1943).

The ligamentum aortae (7) is present in each of the three species and is attached anteriorly to the left pulmonary artery (6). The ligamentum botalli (8) is present as a small vestige, but is much reduced and tends to fuse distally with the right radix aortae (4). In *Colius indicus*, at least, the right ligamentum botalli maintains a thread-like proximal attachment to the right pulmonary artery.

DISCUSSION

It should be pointed out that the Coliiformes are laevo-carotidinae as are the Trogoniformes (Glenny, 1943), certain Coraciiformes (Meropidae, Upupidae, and Phoeniculidae) (Glenny, 1943), the Piciformes (Glenny, 1943) and the Passeriformes (Glenny, 1942). In arrangement-pattern, these forms closely resemble one another, and differ in only minor respects.

Lowe (1939) points out that except for certain minor structural differences the Swifts and Humming-Birds closely resemble the Perching Birds which he would place in a subordinal position in the larger order Passeriformes. At the same time he would place the Pici, Eurylaimi, Cypseli and Trochili as other suborders in the Passeriformes. He also suggests that perhaps some of the Coraciiformes (Wetmore, 1940) might likewise be placed in this larger order.

Based upon my own studies, I am inclined to agree with Lowe, if we are to try to establish probable relationships of larger orders of birds, rather than accord ordinal rank to all groups which do not have all of the important characteristics of extant forms.

EXPLANATION OF PLATE

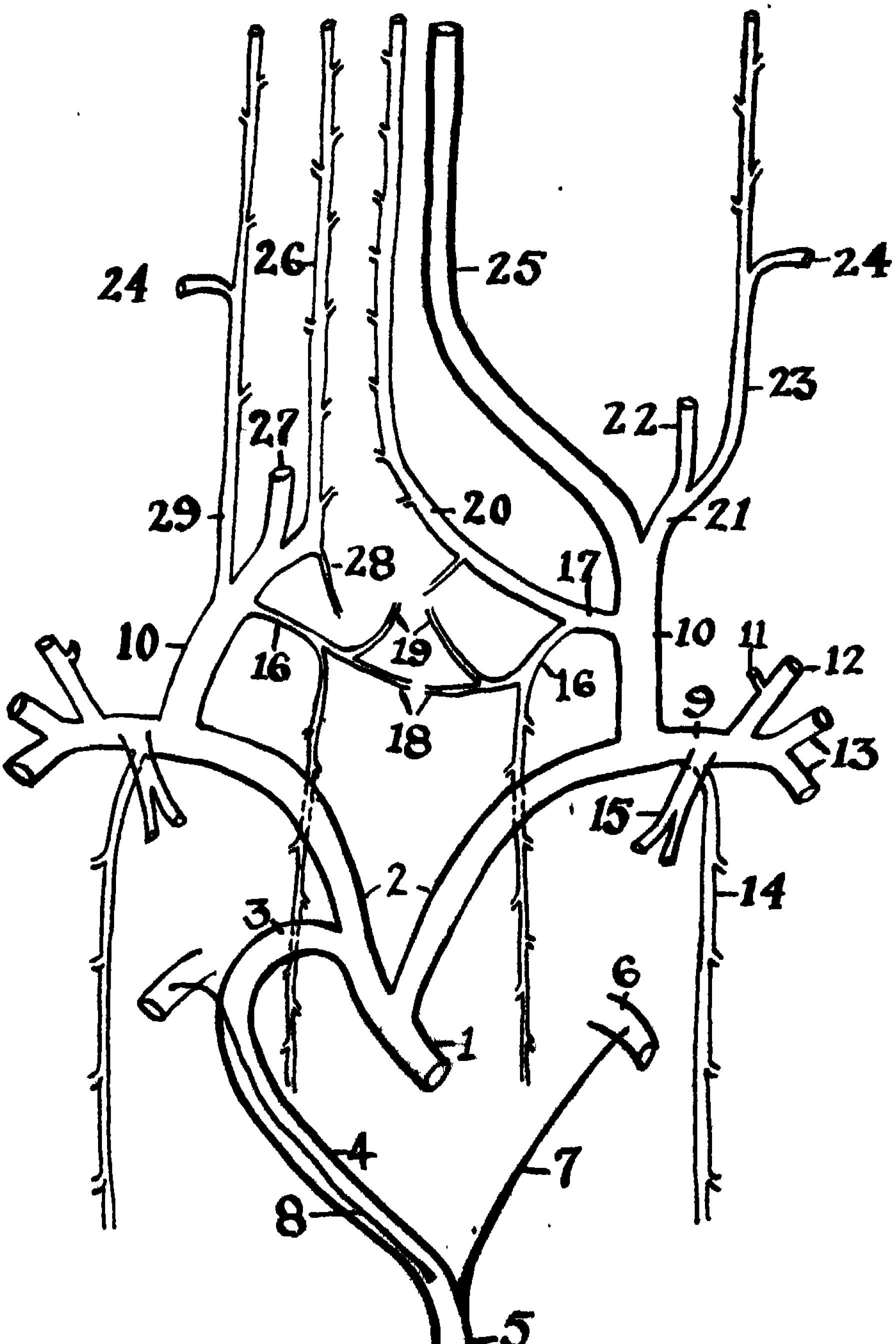
Figure 1. Diagrammatic representation of the main arteries in the neck and thorax of *Colius striatus* Gmelin. Ventral view.

KEY TO ABBREVIATIONS

1. Aortic root.
2. Innominate arteries.
3. Systemic (4th aortic) arch.
4. Right radix aortae.
5. Dorsal aorta.
6. Pulmonary artery.
7. Left ligamentum aortae.
8. Right ligamentum botalli.
9. Subclavian artery.
10. Common carotid artery.
11. Coracoid minor artery.
12. Axillary artery.
13. Pectoral arteries.
14. Intercostal artery.
15. Coracoid major artery.
16. Ductus shawii.
17. Tracheo-oesophageal artery.
18. Syrinx artery.
19. Tracheal artery.
20. Primary ascending-oesophageal artery.
21. Cervico-vertebral artery.
22. Left vertebral artery.
23. Left superficial cervical artery.
24. Scapular artery.
25. Internal carotid (trunk) artery.
26. Secondary or accessory ascending-oesophageal artery (right internal carotid ***trunk*** artery).
27. Right vertebral artery.
28. Basi-cervical artery.
29. Right-superficial cervical artery.

Main Arteries in the Region of the Heart
Fred H. Glenny

PLATE I



While it may be thought by some that there is great variation in soft structures such as arteries, and therefore, these structures cannot be used satisfactorily as evidences of trends in evolution, my experience in this work cannot substantiate such claims. In fact, by a thorough study of the arterial system in the neck and thorax, from early embryonic stages through to the mature adult, one can grasp the main and significant trends of development. This is likewise true of the development-patterns of other structures such as the bony or skeletal system, and of the musculature. Although virtually nothing with reference to growth curves (of bones, etc.) in birds has been done, such work as has been carried out recently would seem to confirm our concept of ordinal developmental-patterns. Such findings are necessary to aid in the final establishment of ordinal and family relationships.

If we are to accept a poly-reptilian concept of avian evolution, we must regard the origin of such birds as the Rhea, Ostrich, Emu, and Cassowary as different from that of the Tinamous, Galliformes, and Anseriformes, and at the same time we should postulate a different origin for the Penguins. In the same vein, we may further conceive of the other birds as being divided into at least two or more groups, present-day forms of which probably had somewhat different reptilo-avian ancestors. Of this latter group, the present-day representatives of the Coliiformes, Trogoniformes, certain Coraciiformes, Piciformes, and Passeriformes[4] along with Cypseli and Trochili[5] may have sprung from a common stock since all of these show distinctive characteristics (several of which are held in common). Individual lines of evolution and development have taken place so that ultimately they have assumed their own distinctive characteristics which are the reasons for according them ordinal rank by our present taxonomists.

It is, therefore, my opinion that if the present orders of birds are to be reclassified, based upon natural relationships, in an effort to establish primitive relationships, the above general group should be presented as the last main order.

ACKNOWLEDGMENTS

The writer wishes to express his gratitude to Dr. Alexander Wetmore, Assistant Secretary, Smithsonian Institution, and Dr. Herbert Friedmann, Curator of Birds, United States National Museum, for their helpfulness and cooperation in making available these and other materials for study, and to Dr. E. Horne Craigie, Department of Zoology, University of Toronto, and Dr. A. L Rand, Curator of Birds, National Museum of Canada, for their suggestions and criticisms during the progress of these studies and in the preparation of this paper.

REFERENCES

Glenny, Fred H. 1942. A Systematic Study of the Main Arteries in the Region of the Heart - Aves III. The Fringillidae, Part 1. Columbus, Ohio Journal of Science, 42 (2): 84–90.

1943. A Systematic Study of the Main Arteries in the Region of the Heart—Aves VI. Trogoniformes, Part 1. Lancaster, The Auk, 60: 235–239. (1943).

A Systematic Study of the Main Arteries in the Region of the Heart—Aves. Piciformes. London, Proceedings of the Zoological Society, Ser. B, 113: 179–192. 1943.

A Systematic Study of the Main Arteries in the Region of the Heart—Aves VII. Coraciiformes, Part 1. Ottawa, Transactions of the Royal Society of Canada, 3rd Ser., Sec. V, 37: 35–53, 1943.

Lowe, Percy R. 1939. IV. On the Systematic Position of the Swifts (Suborder *Cypseli*) and the Humming-Birds (Suborder *Trochili*), with special reference to their Relation to the Order *Passeriformes*. London: Trans. Zool. Soc., Vol. XXIV, Part 4: 307–348. (Plates I–IV).

Sclater, Wm. L. 1924. Systema Avium Aethiopicarum. London, British Ornithologist's Union, pp. 265–268.

Wetmore, A. 1940. A systematic classification of the birds of the world. Smithsonian Inst. Pub., Misc. Collections, 99 (7): 1–11.

---

[4] Wetmore, A., 1940.

[5] Lowe, P. R., 1939.

THREE NEW ZYGNEMATACEAE FROM ARKANSAS

GLENN C. COUCH,
University of Oklahoma,
Norman, Oklahoma

During a study of the algae collected in the Boston Mountain region of Arkansas, two new species of *Zygnema* and one of *Spirogyra* were found. Following are the descriptions of these species.

Zygnema insignisporum sp. nov.

Vegetative cells 24–28μ x 39–71μ, conjugation scalariform, receptive gametangia inflated on the conjugation side; zygospores globose to ovoid 32–35μ x 32–35μ, outer wall of two colorless layers of which the outermost is smooth, the inner scrobiculate with pits 4–5μ in diameter and about 7μ apart; median wall punctate, yellow.

Zygnema transeauianum sp. nov.

Vegetative cells 30–32μ x 20–60μ; conjugation scalariform, receptive gametangia enlarged or slightly inflated on the conjugating side; zygospores globose to ovoid 25–35μ x 33–40μ, somewhat compressed; median spore wall yellow-brown reticulate with large irregular pits 7–12μ across.

Spirogyra castanacea sp. nov.

Vegetative cells 34–37μ x 100–173μ, with plane and walls; 2 to 3 chromatophores making 2 to 3 turns in the cell; conjugation scalariform, tubes formed by both gametangia; receptive cell inflated on both sides; zygospores mostly broadly ellipsoid, rarely ovoid, 48–52μ x 69–73μ, median spore wall chestnut brown, strongly reticulate.

A general summary of the algae of the Boston Mountain region was published in Abstracts of Doctoral Dissertations (No. 38) by the Ohio State University Press, 1942.

SYMPOSIUM ON PREMEDICAL EDUCATION

Alpha Epsilon Delta, national honorary premedical fraternity, sponsored a symposium on Premedical Education at the Cleveland meeting of the Association for the Advancement of Science in September, 1944. More than seventy teachers and administrators from various colleges throughout the country attended. Dr. H. E. Setterfield, national president of Alpha Epsilon Delta, opened the Symposium and Dr. Victor Johnson, secretary of the Council on Medical Education and Hospitals of the American Medical Association, presented a paper on the "Objectives in Premedical Education" from the medical point of view. Dr. C. I. Reed of the department of physiology at the University of Illinois was to have presented a paper summarizing some opinions on premedical training as determined among the faculty and students of the five medical colleges in Chicago. Unfortunately, Dr. Reed was unavoidably absent.

A spirited discussion followed the formal remarks and showed the realization of the many important problems involved in premedical training. Plans for further investigation of these problems were proposed by Dr. Setterfield. Among these is the publication of the papers presented on the Symposium in the November issue of *The Scalpel* of Alpha Epsilon Delta which will be distributed to a large number of teachers and administrators along with a list of the more important questions for discussion brought out at the Symposium. The remarks and suggestions submitted will be published in pamphlet form and circulated among premedical teachers and others interested.

Copies of these publications may be had upon request to Dr. Maurice L. Moore, Secretary of Alpha Epsilon Delta, 3858 Lakewood, Detroit 15, Michigan.

REVIEW PAPERS

(Papers appearing in this section are invited reviews of subjects of wide current interest.)

PENICILLIN: A POTENT NEW CHEMOTHERAPEUTIC AGENT

WM. G. MYERS, Ph.D., M.D.,
The Ohio State University

HISTORY

In 1929 Dr Alexander Fleming (1) at St. Mary's Hospital in London observed a clear zone around a mold contaminant on petri dishes inoculated with *Staphylococcus aureus*. This phenomenon stimulated him to isolate and culture the mold on broth to see if the mold would produce a substance inhibitory to the growth of bacteria under these circumstances. His hypothesis proved to be correct; for, whenever he placed a drop or two of the broth on which the mold had grown on plates on which *Staphylococcus aureus* or each of several other bacteria were growing, large clear areas occurred after a short time as the drops diffused through the agar

Dr. Fleming found by various methods that several different strains of staphylococci were inhibited by the broth with little variation among strains. Other pathogenic organisms which proved to be quite susceptible were *Streptococcus pyogenes*, pneumococci, gonococci, meningococci, *Corynebacterium diphtheriae*, and some strains of *Streptococcus viridans*.

Many organisms were entirely unaffected by the broth. Among these were *Escherichia coli*, *Eberthella typhosa*, *Pseudomonas pyocyaneus*, *Proteus vulgaris*, *Vibrio comma*, *Friedlander's bacillus*, *Hemophilus influenzae* and Flexner's dysentery bacillus.

Dr. Fleming found the broth containing the inhibitory substance for certain bacteria to be no more toxic or irritating than the broth itself, when injected into animals. In the summary to this original paper he modestly proposed that the antibacterial substance might find clinical application in infections caused by organisms susceptible to it.

Since the mold which elaborated the antibacterial substance was recognized by Dr. Fleming to be a member of a large genus of molds, ***Penicillium***, he named the substance penicillin. Although the word has been pronounced several ways and there has been much discussion as to the correct one, the majority usage among workers in the field appears to be pen-i-cil'-lin.

Because penicillin was very unstable and was difficult to produce in large quantities, it excited little interest during the next ten years. Fleming reported its use as a selective bacteriostatic agent for purposes of differentiation of bacteria in two or three papers. In 1932, Clutterbuck et al. (2) devised ways to grow the mold in larger amounts and further described the chemistry of the antibiotic substance.

A sudden new interest in penicillin followed the announcement of Florey, et al. (3, 4) that penicillin is very effective therapeutically and is of extremely low toxicity in contrast to the relatively high toxicity of the antibacterial substances, gramicidin and tyrocidine, isolated by Dubos from soil bacteria. Their papers also included new methods of extracting the antibiotic substance from the mold as well as improved methods of purification.

Since the papers of Florey, et al. appeared in 1940 and 1941, reports of several thousands of cases treated with penicillin have appeared in about three hundred papers.

The startling, almost miraculous, therapeutic results reported by Florey and his co-workers in the successful treatment of hopelessly infected individuals excited such wide interest that in 1941 Florey was brought to the United States by the Rockefeller Foundation to attempt to institute larger scale production than was possible in war-torn England. Here he interested the National Research Council and the Northern Regional Laboratory of the Department of Agriculture at Peoria along with several large pharmaceutical concerns in the possibility of large-scale production. At that time his yields were only about two units per ml. which were too small to be commercially practicable when amounts of the order of one million units were apparently necessary to treat deep-seated infections effectively.

The next important advance, which made large-scale production feasible, came with the discovery by Dr. Andrew Moyer at the Northern Regional Laboratory that addition of corn-steep water (a by-product of the corn refining industry) to the medium on which the mold was grown increased the yields of penicillin to better than forty units per ml

PRODUCTION

At present all penicillin is produced by growing highly selected strains of the mold, ***Penicillium notatum*** (ordinary untested green bread or cheese mold is entirely unsatisfactory) on a suitable medium from which the penicillin is then extracted.

Probably the foremost problem is the maintenance of sterility. It seems paradoxical that such a potent antibacterial agent as penicillin must be produced by a mold grown under aseptic conditions; but it is well known that organisms which are not susceptible to penicillin, may destroy it very readily. Thus Abraham and Chain (5) extracted a substance from ***Escherichia coli*** which they named penicillinase since it destroyed penicillin and it had some of the properties of an enzyme.

The optimal culture temperature for penicillin production by the mold appears to be 24° C. The carbon source in the medium is usually lactose; sodium nitrate may be used as the nitrogen source. A host of trace elements has been claimed to be essential for maximum yields by various workers. Among these zinc ions seem to be very important. As stated above, corn-steep water, the composition of which is incompletely known, greatly increases yields.

Three devices are commonly employed to effect aeration (the mold will not grow anaerobically) and the method of culture is named accordingly.

1. Surface culture method. Until several months ago most of the penicillin was produced by this method in commercial installations. Aeration is by simple diffusion and a fundamental requirement is that the medium be not more than two cms. deep for best yields. The essential problem is then one of sterilization, inoculation and maintenance under aseptic conditions for several days of the large surfaces of medium required for commercial production of penicillin. To do this, racks filled with shallow trays are sometimes used but more commonly the flat-type half-gallon milk bottle is used. Some establishments are said to be using several hundred thousands of these. After autoclaving the bottles containing about 400 ml. of medium each, they are inoculated under aseptic conditions with suspensions of the mold spores by means of spray guns. The bottles are piled on their sides so that the maximum surface of medium in the bottle is presented to the mold for growth. After a suitable time (usually 5–7 days) the pH of the medium will have changed from 4 or 5 to about 7, when the contents are dumped into screening devices to separate the mold which is then discarded. The medium filtrate containing the penicillin is then ready for extraction.

2. Submerged Culture Method. Several plants are now using this method which promises to supplant all other methods for commercial production. One establish-

ment uses several tanks which hold thousands of gallons each. Although the yields per ml. are probably somewhat lower than by the surface culture method, the labor requirements are very much less because the filling, sterilization, inoculation and handling of individual bottles is obviated. In this method aeration is accomplished by vigorous bubbling of sterile air through the inoculated medium. The essential problem seems to be one of sterilization of the huge volumes of air required.

3. Bran Method. In this method aeration is brought about by growing the mold on coarse bran wetted with the medium in large trays or in long rotating cylinders.

According to a report given by Coghill (10) the total production of penicillin in this country is increasing rapidly and it was predicted that sufficient would be available to meet the essential needs of both the military and civilian populations before the end of the year. In March, alone, approximately forty billion units were produced by 21 companies; this is greater than the total amount produced in 1943. When all of the plants are producing to capacity it was predicted that at least 200 billion units per month will be produced by the end of 1944.

The present standard is a pure crystalline solid equivalent to 1650 of the old Oxford or Florey units per milligram. Hence the predicted output of the 21 plants will be only about 9 pounds per day.

EXTRACTION AND PURIFICATION

Several methods have been described for the extraction of penicillin from the culture medium on which the mold has grown. Among the simplest of these is that described by Abraham and Chain (7). The pH of the solution containing the penicillin is adjusted to 1.9–2.0 with phosphoric acid when it is immediately shaken with some solvent immiscible with water such as amyl acetate or chloroform. After separation of the phases the aqueous portion is discarded. The amyl acetate containing the penicillin in acid form is then shaken with small portions of water-containing base such as sodium bicarbonate. This reconverts the penicillin to the sodium salt which is selectively soluble in the aqueous phase.

The resulting solution of the sodium salt of penicillin may be purified further by chromatographic adsorption on columns of alumina or other suitable adsorbents. For clinical use further purification is usually unnecessary (although desirable) beyond removal of amyl acetate dissolved in the solution. Usually the solution is filtered through Seitz bacterial filters and then dried by sublimation of the water from the frozen state under reduced pressure. The product is a yellow powder which is quite stable when perfectly dry and especially if kept in the refrigerator For therapeutic use it is then readily dissolved in water or normal saline.

CHEMICAL PROPERTIES OF PENICILLIN

Needless to say there probably never has been a compound whose isolation and determination of structure has stimulated a more intensive and concerted effort by individual chemists and groups of chemists in universities and pharmaceutical houses. Announcement of pure penicillin in the form of its crystalline sodium salt was first made in October, 1943, by McPhillamy and Wintersteiner of the Squibb Institute for Medical Research (6). This was, of course, a most important step forward and an essential one preliminary to chemical scrutiny of the compound. For obvious reasons publication of the structure and synthesis of penicillin is not anticipated for the Duration even though they may be discovered before the War ends.

Because all reports on the chemistry of penicillin which have been published, and notably the splendid work of Abraham and Chain (7), have been of work on impure preparations, only general properties which are unlikely to be affected by the presence of impurities will be summarized here.

In aqueous solution penicillin is most stable in the pH range 5 to 7. Its anti-bacterial properties are destroyed at increasing rates as the pH of the solution is varied increasingly widely from the above stability range. It is this sensitivity to high acidities which results in loss of its activity in contact with gastric juice and makes inefficient its administration by mouth. The higher the temperature of the aqueous solution at a given pH the more rapidly the anti-bacterial properties are lost. Electrometric titration indicates that a lactone ring is opened during inactivation by alkalies.

Penicillin is readily destroyed by hydrogen peroxide and potassium permanganate but is stable to air oxidation.

In the free (acid) form it is readily soluble in fat solvents such as ether, acetone, esters and dioxane. It is less soluble in chloroform and only slightly soluble in benzene and carbon tetrachloride. The free acid dissolved in ether or amyl acetate is stable several days at room temperature; it is inactivated by passing dry hydrogen chloride through the solutions. It is also inactivated by such primary alcohols as methyl, ethyl, benzyl and by ethylene glycol.

The sodium, potassium and ammonium salts are very hygroscopic and hence soon decompose in contact with air. The calcium, strontium, and barium salts are non-hygroscopic relatively stable white powders, especially if kept cold.

Elementary analysis of the barium salt of penicillin obtained by Abraham and Chain with 500 units of activity per milligram corresponded to the formula $C_{24}H_{32}O_{10}N_2Ba$ with a molecular weight of 645; 508 of this is due to the penicillin itself, free from barium.

Meyer, et al. (8) give the formula $C_{14}H_{19}NO_6$ as best fitting their data. Later (9) they succeeded in obtaining the methyl, ethyl, n-butyl and benzohydryl esters by reacting with the corresponding diazo compounds. In vitro the methyl and ethyl esters were quite active, the ethyl more so than the methyl ester. Moreover there was some indication that the stability was increased as evidenced by successful use in treating mice infected with virulent hemolytic streptococci by giving the esters by mouth.

ASSAY

The concentration of penicillin is measured by a bioassay method which depends on its antibiotic properties. Two of the several methods used will be described briefly.

Cup Assay Method.—A susceptible strain of bacteria (usually *Staphylococcus aureus* 209) is cultured on petri dishes on which are evenly distributed five porcelain or glass cylinders so as to form a seal with the inoculated agar. Into two of the cups thus formed is placed a solution of penicillin of known concentration, usually one unit per ml. Into the other three cups is placed the solution whose content of penicillin is to be determined, after having diluted the solution so that its concentration will also be about one unit per ml. The plates are then incubated at 37° C. overnight. In the morning it will be found that wherever the penicillin has diffused through the agar the growth of the cultured bacteria will have been inhibited. There thus results a clear zone of inhibition around each of the cups. A suitable comparison of the average of the diameters of the zones produced by the solution of unknown concentration with the average for the knowns is the basis of the assay. This method is the most widely used because a sterile preparation is unnecessary and because a large number of assays can be made per person per day.

Turbidimetric Method.—Where greater accuracy or greater speed is essential, turbidimetric methods based on the proportionality between penicillin concentration and inhibition of bacterial growth are used. The necessity of using bacterial filters to sterilize the penicillin solutions prior to assay by this method as it is usually employed is its chief draw-back.

Recently a bioassay method was described (29) by the use of which penicillin concentrations may be determined in 60–90 minutes with an error of less than 5%. It depends upon the inhibition of the reduction of nitrate to nitrite by *Staphylococcus aureus* in the presence of penicillin. The nitrite is determined colorimetrically by a modification of the method of Shinn (30).

The Oxford and Florey unit was originally defined as that amount of penicillin which, when dissolved in 50 ml. of meat extract broth, just inhibits completely the growth of the test strain of *Staphylococcus aureus* (11). At the present time penicillin is measured in terms of a pure crystalline standard assigned the value of 1650 units per milligram. From this it is seen that 0.6 gram of crystalline penicillin is equivalent in antibiotic activity to one million units.

ANTIBACTERIAL ACTION OF PENICILLIN

Many lists have appeared showing the susceptibility or insusceptibility of various bacteria and fungi to the action of penicillin in vitro. The one below is that of Hobby, Meyer and Chaffee (12).

SUSCEPTIBLE STRAINS

Diplococcus pneumoniae
Streptococcus hemolyticus
Neisseria gonorrhoeae
Neisseria meningitidis
Streptococcus viridans
Bacillus subtilis
Clostridium welchi
Clostridium septique
Clostridium histolyticus
Clostridium sporogenes
Clostridium oedemantiens
Clostridium sordellii
Lactobacillus
Cryptococcus hominis

INSUSCEPTIBLE STRAINS

Hemophilus influenzae
Escherichia coli
Eberthella typhosa
Shigella dysenteriae
Proteus vulgaris
Salmonella paratyphi
Salmonella enteritidis
Pseudomonas aeruginosa
Pseudomonas fluorescens
Serratia marcescens
Klebsiella pneumoniae
Staphylococcus albus—1 strain
Micrococcus albus—1 strain
Monilia albicans
Monilia krusei
Monilia candida

In addition to some of the above organisms, Abraham et al. (4) found the following to be susceptible or insusceptible respectively.

Bacillus anthracis
Corynebacterium diphtheriae
Clostridium tetani
Actinomyces bovis

Salmonella schottmuelleri
Salmonella typhimurium
Brucella abortus
Brucella melitensis
Mycobacterium tuberculosis
Pasteurella pestis
Anaerobic streptococci
Vibrio comma
Leptospira icterohemorrhagiae

In preliminary animal experiments followed by administration in four cases of early syphilis in men, Mahoney et al. (13) found that penicillin possessed spirocheticidal activity. Susceptibility of the spirochetes which cause relapsing fever (*Borrelia novyi*) was observed by Heilman and Herrell in experimentally infected mice (14).

Evidence is at hand to indicate that penicillin is ineffective in virus infections. Myers and Lenahan (15) observed the development of chicken-pox in a patient under penicillin therapy for osteomyelitis. Robinson (16) found that penicillin was ineffective in protecting mice from the influenza virus PR8.

The foregoing list of organisms which are susceptible to penicillin contains the names of the greatest killers of man. The number of men who have died in all of the wars since the beginning of history is small in comparison to the number who have succumbed to the diseases commonly caused by these organisms. Mention of only a few would strike terror into the hearts of the bravest armies; pneumonia, meningitis, bacteremia, osteomyelitis, empyema, tetanus, gas gangrene, brain abscess, mastoid and middle ear infections, gonorrhea, et cetera.

That penicillin is not a panacea is attested to by the above list of insusceptible organisms. Moreover, recent reports show that there are numerous strains of some of the organisms, which appear in the susceptible list, that are not affected by penicillin. Fisher (17) found 12 insusceptible strains of staphylococci of 102 strains in his *in vitro* studies with crude penicillin. He also encountered several strains of hemolytic streptococci which were not affected by penicillin. Florey (18) reports that Major Scott Thomson found 4 per cent of staphylococci are resistant to penicillin.

The mode of action of penicillin is not clearly understood. Hobby, Meyer and Chaffee (19) found that penicillin usually acts as a bacteriostatic agent but it may not be bactericidal. Actual killing of hemolytic streptococci was not accompanied by lysis. It seemed that penicillin was effective only during active multiplication of the organisms. The rate of killing increased as the penicillin concentration increased within certain limits, when a given number of organisms was present originally; but no penicillin was destroyed or removed from solution in detectable amounts by the organisms. Abraham et al. (4) found no inhibitory effect on the action of penicillin in the presence of pus, blood, serum, tissue autolysates or peptones; this is in contrast to the sulfonamides.

Gardner (20) describes microscopic changes due to a failure of fission in rod-shaped organisms acted upon by penicillin. There occurred a lengthening of the cells due to growth without division and separation of the cells. In the case of *Staphylococcus aureus* Smith and Hay (21) observed an increase in size of the cells which were cultured in broth containing penicillin. As the cells increased in size, imperfect division occurred as evidenced by the appearance of a clear zone across the middle of the cell.

Welshimer (28) found in studies in the Warburg apparatus that dismutation of pyruvic acid by *Staphylococcus aureus* was inhibited by penicillin.

Several studies have appeared concerning the development of a tolerance of susceptible organisms when exposed to penicillin concentrations which would just permit growth. McKee and Houck (23) reported growth of a type III pneumococcus culture, highly virulent to mice, in a thirty-fold increase of penicillin after 55 serial passages in a broth containing penicillin in concentrations that would not completely inhibit growth. Type specificity of these resistant cultures was retained although the colonies grew more slowly and the capsule was smaller. There occurred abnormal forms with a tendency to clump and chain formation Simultaneously there was a marked decrease in virulence for mice; before passage a lethal dose was about ten organisms but after the fifty-fifth passage, approximately 900 million organisms were required to kill the mice. Nor was the virulence restored after nine mouse passages. Similar treatment with three strains of staphylococci, one strain of *Streptococcus pyogenes* and a type I pneumococcus culture produced the same results. Keefer et al. (24) found that resistance of *Staphylococcus aureus* and other cocci may develop during treatment of patients with insufficient doses of penicillin. However, the penicillin-resistant organisms remained susceptible to the sulfonamides and vice versa.

Penicillin has the widest margin of safety of any known chemotherapeutic agent. Tissue culture studies by Herrell and Heilman (25) showed that the toxicity for lymphocytes, granulocytes, phagocytes and erythrocytes was extremely low with crude preparations containing more than 97 per cent of impurities. Robinson (16), using an impure preparation, found the toxic dose of penicillin to be about 64 times the effective dose when injected subcutaneously into mice. Clinical evidences of toxicity encountered by Keefer et al. (24) such as urticaria, flushing of the face, and local pain at the site of injection were attributable to impurities which had not been removed. Numerous recent reports in which purer preparations of later and improved manufacture describe no unfavorable clinical reactions whatsoever. In the light of this recent clinical experience with the drug, it seems safe to say that overdosage with pure penicillin is virtually impossible.

ADMINISTRATION

Penicillin has been administered locally as wet dressings, via catheters into wounds and body cavities, in ointments, and as a powder—either as the calcium salt or by insufflation with one per cent penicillin diluted with sulfonamide powder (26). It has also been injected subcutaneously, intramuscularly, intravenously, intraperitoneally, intrathecally and into various body cavities and spaces. In general the present practice is to use it locally for burns, surface infections, wounds, etc.; and intramuscularly at the rate of 5,000–20,000 units every 2–4 hours for systemic administration. Occasionally it is given by continuous intravenous drip in overwhelming infections or where an established bacteremia exists. A distinct disadvantage is that it cannot be given efficiently by mouth because of the rapid destruction of most of it by the acid in the stomach.

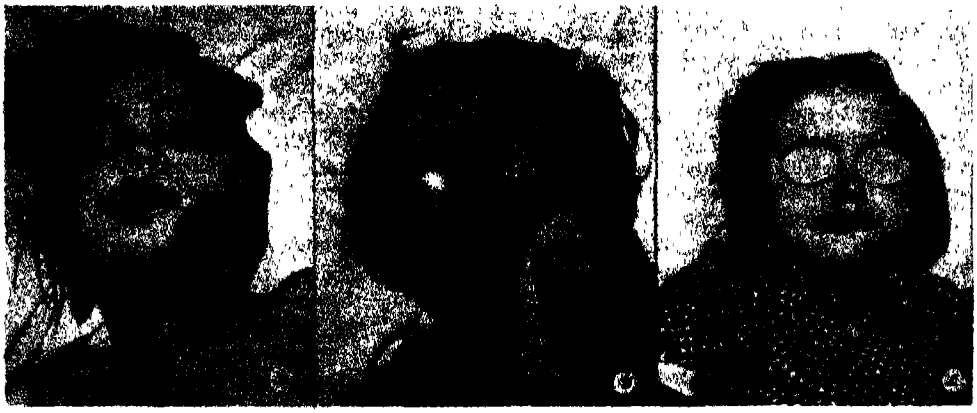


FIG. 1, a and b. Front and side views of patient at onset of penicillin therapy. Extensive facial cellulitis and edema of both eyes may be noted; patient moribund; c, appearance of child ninety-six hours later.

The striking effectiveness of penicillin in overwhelming infections susceptible to it is well demonstrated in the case of a patient treated by Herrell (22). Fig. 1 (a and b) are front and side views of the patient at the start of penicillin treatment.[1] According to her father, this four-year-old girl had bitten the inside of her left cheek prior to the appearance of swelling and redness of the left jaw six days before the pictures were taken. On admission, her temperature was 104° F. and breathing and swallowing were difficult. Examination revealed necrosis in the left alveolar lingual region; this was drained by means of a stab wound into which was introduced a small rubber drain. Blood culture was strongly positive for hemolytic *Staphylococcus aureus*. The leukocyte count was 4500 with 37% neutrophils, 62% lymphocytes and 1% monocytes. During the next five days she was given between 20,000 and 30,000 units of penicillin daily intravenously. Thirty-six hours after the penicillin was started, the blood became sterile. At the time X-ray revealed pneumonia of the right upper lobe, presumably staphylococcal in origin. Fig. 1 (c) was taken 96 hours after initiation of the treatment, at which time she could again swallow and breathe with little difficulty. Fig. 2 (a) shows the child on the ninth day of treatment when her temperature had become normal. Fig 2 (b and c) show her on dismissal, completely recovered. During the twelve days of treatment the patient had received a total of 196,000 units of penicillin or only 0.12 gram of the drug on the basis of the pure crystalline salt!

---

[1] Reprinted from "Further observations on the clinical use of penicillin," by W. E. Herrell, M. D., M.S., Proceeding of the Staff Meetings of the Mayo Clinic, 18: 65–76, 1943, through the courtesy of the author and the Mayo Clinic.

OTHER ANTIBIOTICS

As Professor Fleming has remarked, it would be a most unusual accident if the first successful antibiotic would prove to be the best one. At present there is a wide-spread search for other antibiotics which will be effective against pathogenic organisms that are insusceptible to penicillin; or that will be more easily produced, more stable, can be taken by mouth, or that can be readily synthesized. Among the many which have been described are: gramicidin, tyrocidine, streptothricin, streptomycin, actinomycin, clavacin, gliotoxin, penatin, etc., etc. However, most of them do not combine the lack of toxicity with the effectiveness possessed by penicillin. Of particular interest is streptothricin (27) since it is reported to be effective against the organisms that are responsible for typhoid fever and bacillary dysentery, an important group of gram-negative pathogens against which penicillin is entirely ineffective.

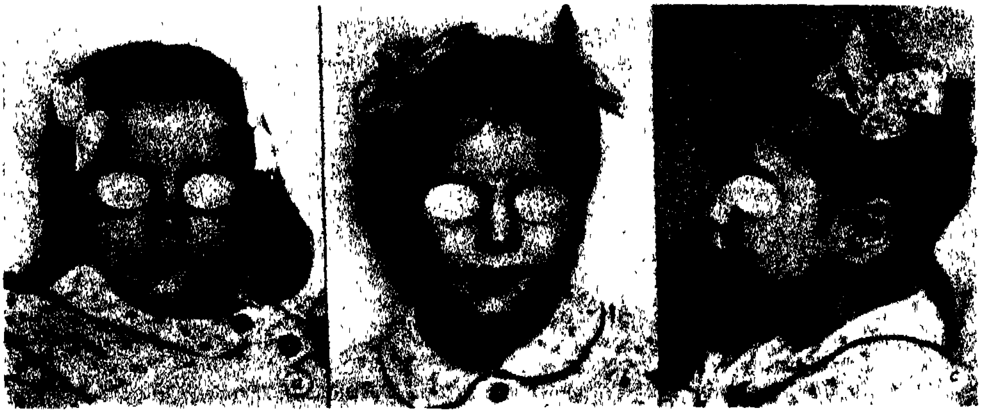


FIG. 2, a. Appearance of patient nine days after onset of treatment; b and c, respectively, front and side views of patient before dismissal Complete recovery.

REFERENCES

(1) **Fleming, Alexander.** Brit. J. Exp. Path., 10, 226 (1929).
(2) **Clutterbuck, P. W., Lovell, R.,** and **Raistrick, H.** Biochem. J., 26, 1907 (1932).
(3) **Chain, E., Florey, H. W., Gardner, A. D., Heatley, N. G., Jennings, M. A., Orr-Ewing, J.,** and **Sanders, A. G.** Lancet, 239, 226 (1940).
(4) **Abraham, E. P., Chain, E., Fletcher, C. M., Gardner, A. D., Heatley, N. G., Jennings, M. A.,** and **Florey, H. W.** Lancet, 241, 177 (1941).
(5) **Abraham, E. P.,** and **Chain, E.** Nature, 146, 837 (1940).
(6) **Drug Trade News,** 18, 27 (1943).
(7) **Abraham, E. P.,** and **Chain, E.** Brit. J. Exp. Path., 23, 103 (1942).
(8) **Meyer, K., Chaffee, E., Hobby, G. L., Dawson, H. H., Schwenk, E.,** and **Fleischer, G.** Science, 96, 20 (1942).

(9) **Meyer, K.**, **Hobby, G. L.**, and **Chaffee, E.** Science, 97, 205 (1943).
(10) **Coghill, R. D.** Chem. and Eng. News, 22, 588 (1944).
(11) **Florey, H. W.**, and **Jennings, M. A.** Brit. J. Exp. Path., 23, 120 (1942).
(12) **Hobby, G. L.**, **Meyer, K.**, and **Chaffee, E.** Proc. Soc. Exp. Biol. Med., 50, 277 (1942).
(13) **Mahoney, J. F.**, **Arnold, R. C.**, and **Harris, A.** Am. J. Pub. Health, 33, 1387 (1943).
(14) **Heilman, F. R.**, and **Herrell, W. E.** Proc. Staff Meet. Mayo Clin., 18, 457 (1943).
(15) **Myers, Wm. G.**, and **Lenahan, F. R.** Unpublished.
(16) **Robinson, H. J.** J. Pharm. Exp. Therap., 77, 70 (1943).
(17) **Fisher, A. M.** Bull. Johns Hopkins Hosp., 73, 343 (1943).
(18) **Florey, H. W.** Brit. Med. J., 2, 654 (1943); Lancet, 245, 638 (1943).
(19) **Hobby, G.**, **Meyer, K.**, and **Chaffee, E.** Proc. Soc. Exp. Biol. Med., 50, 281 (1942).
(20) **Gardner, A. D.** Nature, 146, 837 (1940).
(21) **Smith, L. D.**, and **Hay, T.** J. Franklin Inst., 233, 598 (1942).
(22) **Herrell, W. E.** Proc. Staff Meet. Mayo Clin., 18, 65 (1943).
(23) **McKee, C. M.**, and **Houck, C. L.** Federation Proc., 2, 100 (1943).
(24) **Keefer, C. S.**, **Blake, F. G.**, **Marshall, E. K., Jr.**, **Lockwood, J. S.**, and **Wood, W. B., Jr.** J. Am. Med. Assoc., 122, 1217 (1943).
(25) **Herrell, W. E.**, and **Heilman, D. H.** Am. J. Med. Sci., 205, 157 (1943).
(26) **Florey, H. W.**, and **Cairns, H.** Brit. Med. J., 2, 755 (1943); Lancet, 245, 742 (1943).
(27) **Robinson, H. J.**, **Graessle, O. E.**, and **Smith, D. G.** Science, 99, 540 (1944).
(28) **Welshimer, H. J.** Personal communication.
(29) **Goth, A.**, and **Bush, M. T.** Ind. Eng. Chem., Anal. Ed., 16, 451 (1944).
(30) **Shinn, M. B.** Ind. Eng. Chem., Anal. Ed., 13, 33 (1941).

The Problem of Mitosis

Franz Schrader has added another to the list of excellent monographs in the Columbia Biological Series. This volume treats of the problems of mitosis, many of which are as yet quite unexplained. The term mitosis is used in the old inclusive sense of any nuclear division that involves a spindle apparatus and division of chromosomes, and as such includes "meiotic mitosis." The book opens with a careful account of structures involved in the mitotic process, including the spindle apparatus, the kinetochore, the aster and the spindle constituents. Then follows a clear dispassionate account of the various hypotheses of mitosis, including those concerned with pulling, pushing, viscosity and hydration, electrostatics, diffusion, streaming, hydrodynamic forces and tactoids. Related problems of the interphase, the pairing of chromosomes and kinetochores, the nuclear membrane and other subsidiary phenomena make up a challenging chapter. Such conclusions as can be objectively and critically reached are presented in the final chapter. Students of cytology must read this masterful summary before proceeding with further attempts at solving the problems of cell division. A bibliography of nearly 500 titles completes the book. The illustrations are few but very clear, and are used just where they are needed.—*L. H. Snyder.*

Mitosis: The Movements of Chromosomes in Cell Division, by Franz Schrader. 110 pp. New York, Columbia University Press, 1944. $2.00.

Permeability Up To Date

For nearly twenty years there have been no attempts at a monographic treatment of the topic of permeability. Within the past two years two such books have been published. One of these, written by two well-known American authorities on the subject (Brooks and Brooks, The Permeability of Living Cells. Julius Springer, Berlin, 1942), has unfortunately not become available because of transportation restrictions resulting from the war. The other book is "The Permeability of Natural Membranes," by Hugh Davson and J. F. Danielli. This is a volume which will appeal more to specialists than to the general reader, but no one whose work lies within the field of permeability or related phenomena can afford to overlook it. All phases of the topic are discussed and the book should be profitable reading for both plant and animal physiologists. Mathematical formulations of diffusion, rates of penetration, and related phenomena are developed in some detail. There is a graphic chapter on the structure of the plasma membrane. Permeability to various classes of substances such as non-electrolytes, gases, water, proteins, lipoids, ions, weak electrolytes, and dyes are considered as separate topics. One chapter is devoted to the effects of narcotics, another to the effects of temperature on permeability. There are also chapters on such specialized topics as potential measurements and permeability, haemolysis, permeability in relation to secretion and the permeability problems of the kidney. The final chapter is a discussion of the theories of cell permeability. A list of key references is appended to each chapter. There are numerous figures and an index.—*B. S. Meyer.*

The Permeability of Natural Membranes, by Hugh Davson and J. F. Danielli. 361 pp. Cambridge: at the University Press; New York: The Macmillan Co. 1943. $4.75.

INDEX TO VOLUME XLIV

Annual Report, Ohio Academy of Science, 193.
Arteries in Region of Heart—Aves, 28, 273.
Ascorbic Acid in the Diet, 123.
Auglaize County, Ohio Forests, 103.
Aves, Arteries, 28, 273.

Binkley, Lowell E., 145.
Blank, Fritz, 51.
Bogs, Analysis of, 11.
Botanical Microtechnic, 36.
Britton, M. E., 39.

Caldwell, John S., 57, 252.
Cancer of the Breast, 51.
Census of Fish Catch in Lake Erie, 69.
Central American Psillidae, 57.
Chlorophyceae from Puerto Rico, 39.
Chrysococcus asper, 26.
Chrysomelidae of Ohio, 129.
Cicadellidae, Nomenclatorial Notes, 272.
Cixiidae, 252.
Clams of Auglaize County, Ohio, 167.
Clark, Clarence F., 167.
Coal, 1.
Coal, History in Ohio, 255.
Coal, Northernmost in Ohio, 255.
Coleoptera, List for Ohio, 129.
Coleoptera, New Species, 90.
Coleus, Genetics of, 18.
Columbiana County, Ohio, 1.
Conglomerates of Ohio, 75.
Corn Pericarp Mutation, 143.
Cosmarium, New Species, 25.
Couch, Glenn C., 277.
Crayfishes of Ohio, 95.

DeLong, Dwight M., 89, 236, 272.
Debarya, 244.
Dikraneura, 242.
Doan, Kenneth H., 69.
Dolomites, 219.
Dragonfly Nymphs, Key to, 151.
Dunnigan, Margaret M., 123.

Education, Premedical, 277.
Erythroneura, 242, 265.

Fishing Effort at Indian Lake, 145.
Fishery in Lake Erie, 69.
Forest Resources, 103.

Gastric Ulcers and Ascorbic Acid, 123.
Genetics of Coleus, 18.
Glenny, Fred H., 28, 273.
Gysel, Leslie W., 103.

Hatton, L. H., 245.
Hodgkin's Disease, 245.
Hodgkin's Syndrome, 245.
Hoster, H. A., 245.
Hughes, John H., 129.

Indian Lake Fishing Effort, 145.
Irrigation Project, A Unique Prehistoric, 203.

Jones, Clyde H., 188.

Kent, George N., 11.
Key to Genera of Dragonfly Nymphs, 151.
Kittanning Coal, 1.
Knull, Dorothy J., 239, 269.
Knull, Josef N., 90.
Krauss, Robert W., 11.

Lackey, James B., 26.
Leafhoppers, 57, 89, 236, 239, 272.
Leech, Biology of, 31, 177.
Lewis, Martha N., 123.
Limestone of Ohio, 219.

Mahoning County, Ohio, 1.
Menopause and Cancer, 51.
Mexican Psillidae, 57.
Mexicananus, New Genus, 89.
Microtechnic, 31, 36, 177.
Miller, John A., 31, 177.
Mougeotia, 238, 244.
Mutation in Corn Pericarp, 143.
Myers, Wm. G., 278.

Naiades of Auglaize County, Ohio, 167.
Nerve Tissue, Staining of, 31.
Neurological Microtechnique, 177.
New Hampshire Bogs, 11.

Ohio Academy of Science, Annual Report, 193.
Ohio Academy of Science, Research Fund, 213.
Ohio Coal History, 255.
Ohio Vascular Plants, Additions, 188.
Osborn, Herbert, 213.
Ovipositor Studies of *Erythroneura*, 265.

Parabolocratus, 236.
Penicillin, 278.
Peterson, Alvah, 151.
Prehistoric Irrigation Project, 203.
Premedical Education Symposium, 176.
Prestaining, 36.
Psillidae, New Species, 57.
Puerto Rico Algae, 39.

Research Fund, Ohio Academy of Science, 213.
Rhodes, Rendell, 95.
Rife, David C., 18, 143.

Sandstones of Ohio, 75.
Shepard, F. W., 245.
Shetler, M. R., 123.
Shetrone, H. C., 203.
Sirogonium, 243, 244.
Sphenisciformes, 28.

Spirogyra, 238, 243, 277.
Staining Nervous Tissue, 31, 177.
Stirellus, 239.
Stout, Wilber, 75, 219.
Stratigraphy, Ohio Counties, 1.
Sturgeon, Myron T., 1, 255.

Taft, Clarence E., 25, 238.
Tenucephalus, 236.
Tiffany, L. H., 39.
Trautman, Mary Auten, 265.
Typhlocyba, New Species, 269.

Vascular Plants of Ohio, Additions to, 188.

Wittlake, Eugene B., 36.
Wright, Mike, 151.

Xanthophyceae from Puerto Rico, 39.
Xestocephalus, 239.

Zygnema, 244, 277.
Zygnemataceae, New Species, 238, 243, 277.
Zygnemopsis, 244.
Zygonium, 238.

I.A.R.I. 75

INDIAN AGRICULTURAL RESEARCH
INSTITUTE LIBRARY, NEW DELHI

Date of Issue	Date of Issue	Date of Issue
15-3-58		
18.3.60		
19.4.60		
1[illegible].10.62		
25-7.11		

GIPNLK—H-40 I.A.R.I.—29-4- 5—15,000